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ENERGY, FUELS AND RELATED EQUIPMENT

GAS INDUSTRY COMPETITION WINNERS EXCHANGE EXPERIENCE

Moscow GAZOVAYA PROMYSHLENNOST' in Russian No 5, May 77 pp 2-5

[Article by A. I. Tsegel'skiy of Mingazprom [Ministry of Gas Industry]: "A Conference of Advanced Production Workers"; passages enclosed in slantlines printed in boldface]

[Excerpts] The Ministry of Gas Industry marked the beginning of the Tenth Five-Year Plan with a good start. The plan and the socialist commitments which the industry's collectives adopted for the first year of the five-year plan and for the first quarter of 1977 were carried out successfully.

In March 1977 an All-Union Conference of Advanced Gas-Industry Production Workers—winners in socialist competition—met in Moscow. The tasks of the conference were to demonstrate the achievements of advanced production workers, to exchange experience in the wide dissemination of advanced initiatives, to improve the organization of socialist competition and to achieve the best possible indices.

Workers, brigade leaders, production-section managers and responsible Ministry of Gas Industry workers introduced in their speeches concrete suggestions for raising production effectiveness and quality, improving the organization of socialist competion and exchanging advanced experience.

Chief of the Administration for the Organization of Work, Wages and Worker Personnel V. N. Nekhayev, Deputy Chief of the Administration for the Recovery of Gas and Gas Condensate G. M. Vasyayev, Deputy Chief of the VPO [All-Union Production Association] Soyuztranspodzemgaz V. G. Kurchenkov, and Deputy Chief of the Administration for the Drilling of Gas and Gas-Condensate Wells V. A. Nurshanov emphasized that, in order to raise production effectiveness and work quality, collectives should aim their efforts toward:

/In the recovery of gas and gas condensate/—the introduction of progressive technical equipment for recovery, the achievement of maximum growth in the recovery of gas and gas condensate throughout the regions which are being developed and the maintenance of a stable recovery level in other

regions, a reduction in the inventory of inactive wells and a rise in the coefficient of their operation, a rise in the quality of the treatment of gas for long-distance transport, and the introduction of an OST [All-Union Standard] for gas;

/In the treatment of gas/—an increase in the amount of gas treated, a rise in the extraction of target products and an improvement in the quality of the product produced;

/In the transport of gas/—a rise in the operating effectiveness and reliability of arterial gas pipeline systems, an uninterrupted supply of gas for the national economy, and a reduction in gas losses and in the labor intensiveness of operations;

/In drilling and in geological exploration/—a sharp reduction in construction time, the turnover of wells from the drilling activity ahead of schedule, a reduction in losses and in nonproductive-time expenditure, an increase in drilling speeds, and fulfillment of the plan for an increase in industrial gas reserves;

/In machine building/— rise in the utilization level of production capacity, a reduction in the metal intensiveness and labor intensiveness of articles, a rise in output quality, an increase in consumer-goods output, and regularity of the work pace;

/In construction/—the turnover of facilities on time or ahead of time with high quality indicators, and a rise in the industrialization level of construction work; and

/In scientific research and planning/—an increase in the economic effectiveness of scientific deevelopments, a shortening of the "research and production" cycle, improvement of design and estimating documentation, and a reduction in the budgeted costs of construction.

The actual means for developing workers' initiatives and for finding and using production reserves, thereby fulfilling or overfulfilling state plans, were and still remain socialist competition and the movement on behalf of communist labor.

As Comrade L. I. Brezhnev noted in a speech to the 16th Congress of Trade Unions of the USSR, "Competition today is inseparable from the scientific and technical revolution. It is being concentrated increasingly around the problems of effectiveness and quality. It has been aimed at achieving the best final national economic results. It is linked most intimately with counterplans, under which the initiative and selfless labor of millions have been expressed so brightly.

"Not only advanced workers and winners are revealed during the competition but also the laggards. Competition will thereby help to focus efforts on

the correction of deficiencies and the tightening up of lagging sections, in order to speed up the overall upsurge."

These words reveal the whole essence of socialist competition.

Conference participants, while discussing the successes of the collectives, pointed to deficiencies which still exist and to the need for maximum use of production reserves. It was particularly noted that in drilling and derrick construction, the annual amount of work of the best brigades exceeds significantly the average indices for UBR's [drilling operations administrations]. Not all brigades which repair gas-pumping stations provide for high-quality repair with a guarantee; the current-production services are slow in reducing the inventory of idle wells; the treatment of gas for long-distance transport is not adequate; and there are great losses and consumption of gas for operational needs at the pump stations.

In a unanimously adopted appeal, participants of the All-Union conference of advanced production workers called upon all wage workers, engineers, technicians and white-collar workers of Ministry of Gas Industry organizations and enterprises to promote socialist competition widely for a worthy greeting to the 60th anniversary of the Great October Socialst Revolution and for the fulfillment of national economic plans for 1977 and for the Tenth Five-Year Plan as a whole ahead of time.

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GEOLOGICAL STUDY OF CASPIAN DEPRESSION POORLY INTEGRATED

Moscow GAZOVAYA PROMYSHLENNOST' in Russian No 5, May 77 pp 8-11

[Article by L. V. Kalamkarov (MINKh i GP [Moscow Institute of the Petrochemical and Gas Industry] imeni Academician I. M. Gubkin): "Problems of Gas Exploration in the Caspian Depression"]

> [Text] "Speed up the discovery and exploration of new deposits of oil, natural gas and condensate, primarily in...the Kazakh SSR (the Caspian depression). Provide for the preparation of additional explored reserves of oil and gas in the regions where deposits are being developed in the European part of the USSR."—From "The Main Directions for Developing the USSR's National Economy During 1976-1980."

The Caspian depression, despite its extremely favorable geological conditions for mineral resources, lags greatly behind other regions of the Volga-Urals gas-bearing province in explored reserves and relative significance of the gas and oil producing industries. The matter of discovering new gas and gas-condensate deposits in the rock series above the salt is not proceeding satisfactorily, and practically not one industrial deposit has been discovered in the subsalt complex of sediments. One of the causes of this situation is the severe shortage of a backlog of structures which have been readied for exploration. The explanation for this should be sought not just in the complexity of the geological structure which is inherent to those provinces in which saline tectonics have developed, but also in the poor study of many regions of the depression, a dissipation of forces and material resources which are being expended on prospecting and exploratory work, and the poor overall effectiveness of these operations.

Geophysical methods and deep drilling play the major role in studying the territory in questions. This predetermines a close relationship between them at all stages of research.

The Caspian depression has now been covered by aerial magnetic and gravimetric surveys, and electrical exploration, mainly MTZ [magnetotelluric

sounding] and MTT [telluric-current method] work, has been conducted over a substantial portion of it. Seismic methods, which provide the explorers of the earth's depths with the most complete information about the tectonics of the objects being studied, have been developed especially widely. The results of seismic exploration are being used for geological interpretation of the data of other geophysical methods, and they are also a basis for the guidance of the expensive and labor-intensive drilling operations.

A great many core, test and exploratory holes have been drilled in the depression, while stratigraphic and parametric holes have been drilled in fewer numbers.

The use of geophysical research methods in combination with deep drilling gives definite information about the contours and composition of the crystalline basement and the structure of the depression's sedimentary mantle, and it enables tectonic regionalization of the area and the prospecting of promising areas and of local structures and the preparation thereof for exploration for gas and oil.

Notwithstanding the important practical results of the geological and geophysical research, there are many deficiencies in it which are related both to the objects and choices of direction of the work and to the methodology for doing the work. The amounts of regional seismic research, which, on the whole, lags behind prospecting operations, are completely inadequate. The inner and major portion of the depression has been covered by sparse regional seismic traverses, the data from which yield only the most general notions about the structure of the folded basement and the sedimentary mantle, especially with regard to the subsalt horizons. The network of cross-sections in the side and near-side zones is denser but even that does not enable an unequivocal judgment about the tectonic conditions which are inherent to these sections of the territory. Most of the cross sections were worked out by one or, more rarely two, of these methods: MOV [reflected-wave method], MRNP [controlled directional reception method], KMPV [correlation method of refracted waves], GSZ [deep seismic sounding] or MPOV [expansion unknown], each of which is characterized by a definite degree of informativeness about the structure of the various structural complexes which is inherent to that method but does not always correlate with the information content of the other methods.

Seismic research by regional traverses have not always provided adequate information about the physical parameters of the sediments' cross-sections. This is caused by the fact that stratigraphic and parametric holes have been deployed about the territory extremely unevenly, and many sections which are vast in area are not covered by drilling at all. The holes are not always brought down to the designed depth, and some of them are eliminated for technical reasons.

Cases have occurred where the characteristics of the cross-sections of a hole were not adequately confirmed by test core data and the field's

geophysical data, including sound logging data. The stratigraphic holes are, in essence, doing the work of parametric holes, and later they are replaced by prospecting holes.

The sparse network of cross-sections, the lack of reliable information about the physical characteristics of the sediments' cross-sections and the stratigraphic tie-in of horizons, and the impossibility of making an integrated geological interpretation of the data obtained by each traverse have caused a low general effectiveness of regional research directed toward discovery of the main features of the Caspian depression's deep structure. The sketchiness and equivocalness of the resulting geological and geophysical data about the basement's structure and the behavior of the horizons of the subsalt rock masses which are obtained by various organizations within the region point distinctly to this.

The overall level of the research which is directed toward prospecting and preparing gas-bearing areas for exploration is not high. This is caused to a great extent by the complicated geological conditions. Moreover, such a situation is explained by the low effectiveness of geophysical research and errors in organizing the conduct of deep drilling. Thus, the methodology of geophysical research does not completely satisfy the requirements of a solution to the geological problems which have been posed; the amounts of drilling work which have been done at the various areas are inadequate both for a correct geological interpretation of the geophysical results and for answering the question of the subsequent direction of operations. There is also a definite lack of coordination between the specific designation of the holes and the degree of validity of their location.

In the Paleozoic subsalt sediments the most promising objects can be the large, gently sloping platform-type uplifts, and in the complex above the salt they can be the deeply buried arch uplifts in the vast troughs between the domes. Structures in the zones of the rocks which abut the buried slopes of salt plugs and domes, including the sections below benches which are shielded by faults in uplifted sections of the wings or on their periphery, are no small reserve for the accumulation of gas and oil stores. The difficulty of studying the named objects is explained by the great depth of their location and the complex geometries of their surfaces, by the wide development of a network of disjunctive dislocations and zones of stratigraphic unconformities which are dictated by the block nature of the basement structure and by an intensive manifestation of saline tectogenesis.

The task of providing prospecting and exploratory drilling with the required inventory of reliably prepared structures was for many years entrusted to such seismic methods as MOV and KMPV and their simplest modifications. The use of these methods gave positive benefits in prospecting for deposits in the Mesozoic sediments which are associated with the arch and near-arch portions of the domes. At the next stage of study of the depression, in solving more complicated and diverse tasks on mapping the

structures in the rock masses of the Permian-Triassic and in the subsalt sedimentary complex, the results of the MOV and KMPV work proved to be not reliable enough.

For example, various authors who were working in the Keniyak-Mortuk area in the eastern part of the Caspian depression with the very same seismic data drew up maps for the horizons of the subsalt floor which differed sharply from each other and were not confirmed by the drilling data. Errors in determining the depth of deposition of reference horizons sometimes reached hundreds of meters.

Opportunities for seismic exploration have increased through the involvement of such progressive methods as RNP [controlled directional reception], OGT [common-depth point] and VSP [vertical seismic profiling]. The conversion to apparatus which magnetically records seismic signals, the processing of the data on analog machines, and the introduction of digital recording of waves with later processing on an electronic computer have been of great value. As a result, data quality has improved, and the volume of useful information has grown. But despite the improvement of methodology and equipment for field observations and processing of primary data, the effectiveness of seismic exploration at prospecting structures and the preparation of them for deep drilling still remain low. This is reflected not just in the lack of general correlation of seismic waves from reference geological boundaries but also in the poor precision of structural features. The discrepancies between seismic exploration data and drilling data, disagreements about depths, and so on, testify to this. All this is the result of imperfections of our knowledge about wave propagation speeds, which frequently are measured by cross-section and by area because of the sharp nonuniformity of the sedimentary mantle, a lack of trustworthy information about the position of the salt surface, and the weak attention paid to the integrated use of geophysical data.

The main sources of information about the speed characteristics of the cross-section and seismic wave confinement are the sound-logging data of deep holes and vertical seismic profiling. However, the volume of such information usually is inadequate for a confident interpretation of the data, since the number of holes for each object is limited, each hole is drilled under definite structural conditions, and the data obtained here cannot be extended to other sections. Moreover, many holes do not at all disclose the subsalt sediments, which especially interest us, to an adequate depth.

Information about effective speeds, which are determined by A. B. Musgrave's method, are being used to supplement seismic observations in holes in order to disclose the speed pattern. But these operations were conducted in extremely limited numbers. In order to obtain an adequate representation of the spatial distribution of speeds, observations by this method should be large in scale and cover all sections of the area being studied.

A detailed study of the morphology of the saline rock masses is necessitated by the following factors: in the first place, the position of the hydrochemical sediments determines to a great extent the structural features of the portion of the cross-section above the salt and the formation therein of gas and oil; in the second place, only when there is positive knowledge about the relief of the salt and its thickness is it possible to assure adequate precision of the structure of the horizons in the subsalt complex. Inadequate consideration of the thickness of the salt-bearing sediments and the refraction of the waves on this surface distort considerably the picture of the subsalt structures in cross-section and in plan view. This leads, in the final analysis, to incorrect notions about their dimensions and position. A completely definite conclusion should follow from this: in prospecting and exploring the sedimentary mantle of the depression, attention must be paid to study of the salt-bearing complex no less than to tracing the reference horizons in the other parts of the cross-section.

No one has taken exception to this obvious situation, but in practice inexcusably inadequate attention is actually being paid to this question. They are still trying to study the salt's surface by ordinary surface methods, which are based on the recording of reflected or refracted waves. The fact that this boundary is unlike others in its "nonreflecting properties" and very complicated shape, and, therefore, regular waves of this type cannot be formed at many of its portions, is not being considered. The indirect characteristics which are being used for these purposes yield only a most general idea about the configuration of the salt bodies. Such information cannot be used either for establishing the salt's zone of contact with the sediments above the salt or for introducing appropriate corrections which consider the influence of the halogenic rock masses when the position of the boundaries of the deeper parts of the cross-section is being determined.

The method of hole seismic exploration, which combines observations at the ground surface and within the holes, has been used extremely successfully at West Kazakhstan enterprises. The MSS [in-hole method of seismic exploration], which is based on the recording of transmitted waves, yields more complete and authentic information about the morphology of the salt cores of the domes. However, this method is still being used inadequately, as is the inverse time-travel curve method (MOG), which, in combination with MSS, can greatly increase the geological effectiveness of seismic research during study of the salt-surface relief.

An analysis of the results of the research which is being carried out in the Caspian depression indicates that not one of the geophysical methods now being applied separately will provide for a solution for all the several questions which are associated with throwing light on the structure of the various objects. The effectiveness of the work can be increased only by improvement of the geological-geophysical methods being used and by integrating them.

For some years now the Branch Laboratory for Study of the Effectiveness and Areas of Geological Prospecting for Gas and Oil in Salt-Dome Areas of MINKh and GP imeni I. M. Gubkin has been doing work in this area. The main objects of the laboratory's research are the provinces of saline tectonics development of the south of the East-European platform—the Pripyat' (Belorussian SSR), Dneprovsk-Donetsk (Ukrainian SSR) and Caspian (Kazakh SSR and RSFSR) depressions.

The laboratory has worked in the indicated regions on the integrated geological interpreation of geophysical and drilling data, as a result of which ideas about the geotectonics of the regions were greatly augmented, a number of new perspectives on gas and oil structures were revealed, and an idea of their shapes, sizes and depths of deposition was obtained.

About 50 areas at which the presence of as-yet undiscovered positive salt and subsalt shapes had been conjectured were discriminated for the Pripyat' depression (Belorussian SSR) area. Operations of Belorussian production organizations at 24 of these areas established subsalt uplifts, and oil deposits were discovered at the Marmovichi, Zolotukhino, Nadvin and other structures.

In the Dneprovsk-Donetsk depression (Ukrainian SSR) 130 structures were isolated, of which 30 have already been confirmed by seismic exploration. Gas deposits were discovered at the East-Rybalka structure (the Sidoryachskoye) and at Maysk (the West Krestishchenskaya) structure.

In the Caspian depression 14 probable uplifts of salt sediments have been noted, of which the Zavolzhskoye, Kushumskoye and Gur'yevskoye have been confirmed by seismic operations or by drilling. Moreover, it has been possible to isolate throughout the Aralsor and Kushumskoye regions more than 20 buried salt structures in the areas between domes which have been recommended as first priority for the organization of detailed prospecting and exploratory work.

Research conducted by the laboratory confirms the need for wide and intimate integration of various geological-geophysical methods both during the conduct of field work and during the geological interpretation of the data. The use of a complex of methods will enable the discovery of promising structures to be speeded up and the amounts of seismic research and drilling and, consequently, the overall cost of the work which is being conducted, to be reduced.

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MERITS OF COMPRESSORS FOR UNDERGROUND GAS STORAGE TOLD

Moscow GAZOVAYA PROMYSHLENNOST' in Russian No 5, May 77 pp 15-18

[Article by P. P. Tyurin, B. M. Smereka and Yu. N. Vasil'yev of VNIIGaz [All-Union Scientific-Research Institute for Natural Gas]: "Modern Piston-Type Gas Transfer-Pump Units for PKhG [Underground Gas Reservoir] Stations"]

[Text] In accordance with the existing trends of uninterrupted growth in the length of arterial pipelines which pass through regions with a distinct continental climate, an increase in gas consumed for municipal and household needs, and growth in the number of consumers who require an uninterrupted gas supply, the role of large reserve storage which is built close to the main gas-consuming centers is greatly increasing.

An inseparable and extraordinarily important part of underground gas reservoirs (PKhG's) are the compressor stations which compress the gas when it is pumped into the beds, and, in some cases also, compress the gas during withdrawal from the reservoir for further transport to consumption sites.

During the last [sic] five-year plan the active volume of the reservoirs will be greatly increased. The long-range requirements for gas-pumping units for KS's [compressor stations] for underground gas reservoirs, taking the growth in PKhG volume into consideration, has been cited in a VNIIEGazprom [All-Union Scientific-Research and Experimental Institute for the Gas Industry] work [1].

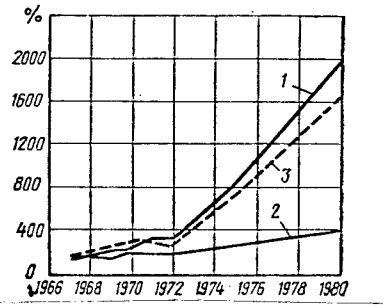
A chart which was made (see graph) reflects the trend in growth of the installed capacity of the GPA's [gas transfer-pumping units], the amount of gas recovered, and the active volume of underground reservoirs. According to forecast data, the growth in total capacity of the GPA inventory will greatly surpass the increase in the active reservoir capacity, which corresponds with the trend toward raising the pressure for delivering the gas into the PKhG's. Extraordinarily high rates in growth of the establishment of PKhG's and the requirement for extremely large and continuously increasing capacities of transfer-pumping equipment necessitate a

qualitative improvement of the GPA's with a simultaneous increase in the unit capacity and number of compressors produced.

Relative growth of:

(1) Installed capacity of GPA's [gas transfer pumping units].
(2) Gas recovery volume.
(3) Active PKhG [underground gas reservoir] capacity.

Indices for 1966 are adopted as 100 percent.



In accordance with the draft of the plan for introducing compressor stations in 1976–1980, the overwhelming majority of PKhG stations will be equipped with piston-type gas transfer-pumping units, including 10GKN gas-driven compressors (GMK's) (with a total power of 150 mVt), MK8 GMK's (110 mVt) and DR 12 GMK's (about 200 mVt). The preference for use of piston GPA's is explained by the complete correspondence of these units with the technological requirements of the PKhG's and the relatively small unit power which is required for these facilities.

Considering the ever-increasing requirements for modern transfer-pumping units for underground gas-storage stations, VNIIGaz, jointly with manufacturing plants and design and operating organizations of Mingazprom [Ministry of Gas Industry], has been working for several years on improvement of the inventory of PGPA's [piston gas-transfer-pumping units] and on the creation of new types and modifications of compressing machinery which are specially intended for work at PKhG stations.

KS's of PKhG's are divided into two main groups, depending upon the technological requirements which are made on the PKhG stations:

1. Stations at which a GPA which provides for compression of the gas only during its injection into the bed must be installed. The pressure during reception for gas transfer-pumping machines can vary from 40 to 55 kilograms-force/cm^2 for gas pipelines with a rated pressure of 56 kilograms-force/cm^2 and from 50 to 75 kilograms-force/cm^2 for gas pipelines of 76 kilograms-force/cm^2 rated pressure, and, during delivery, from 120 to 200 kilograms-force/cm^2, depending upon the location of the PKhG station and its distance from the route of the main gas pipeline from which the gas enters the reservoir, as well as the injection regime which has been adopted and the geological characteristics of the reservoir itself.

2. Stations where GPA's are established which should provide for compressing the gas both during its injection into the bed and during withdrawal from the reservoir.

Until recently it was assumed that stations of this group would be equipped with transfer-pumping units of two modifications: GPA's which operate in

the injection regime (compression parameters are similar to the parameters of GPA's at PKhG stations of the first group), and GPA's which operate in a regime of withdrawal of gas from the reservoir. Machines of the second modification are close in compression parameters (suction and delivery pressures) to the so-called "line" modification of GPA's which are installed on arterial gas pipeline KS's. The suction pressure for these machines is in the 25-52 kilograms-force/cm^2 interval at delivery pressures of 56 or 76 kilograms-force/cm^2, which corresponds to similar operating pressures of arterial gas pipelines, into which the gas is fed after its removal from the underground reservoirs. Such a complication of the PKhG station makeup through the mandatory introduction of two compressor units was occasioned primarily by the need to operate the GPA's in an extraordinarily wide band of suction and delivery pressures.

During the injection regime (the first groups of PKhG KS's), the GPA's are capable of compressing the gas from 40-55 to 70-150 kilograms-force/cm^2. Productivity of the various machines is in the 0.42 to 17.10 million cubic-meters per day range, depending upon both the GPA's unit capacity and the operating regime.

Transfer pumping units operate in parallel when injecting gas into a reservoir. "Injection-regime" units meet the technological requirements for gas pipeline suction pressures (40-55 kilograms-force/cm^2) with a rated pressure of 56 kilograms-force/cm^2, but do not satisfy the suction pressure requirements (the interval $p_{vs\ [suction]}$ = 55-75 kilograms-force/cm^2) for gaslines with operating pressure of 76 kilograms-force/cm^2 and do not provide for compressing the gas higher than 150 kilograms-force/cm^2 -- to the 180-200 kilograms-force/cm^2 required.

Thus, in order to provide for the necessary conditions for operating long-term gas storage with increased reservoir pressure in coming years, a new multipurpose PGPA modification of increased unit capacity must be created which will provide during reception a compression pressure of 40-75 kilograms-force/cm^2 and, on the injection line, 120-200 kilograms-force/cm^2.

The mix of transfer-pumping machines which are used at PKhG stations for the withdrawal of gas includes eight different modifications based on GMK's of the 10GKN, MK8 and DR12 types, and also the opposition compressors 4M25 and 6M25 with electric drive. Machines of this group are capable of providing for compressing of gas from 25-52 to 56-76 kilograms-force/cm^2, meeting the technological requirements which are made on GPA's in the gas-withdrawal departments at PKhG stations.

An improvement of transfer-pumping machines of the "withdrawal group" should call for the creation of a single modification of the DR12-type GMK which can compress gas from 25-52 to 56-76 kilograms-force/cm^2 and which will find wide application both at departments which withdraw gas from reservoirs at PKhG stations and at line-type compressor stations of arterial gas pipelines.

The MK8/[46-(67-103)]:[(23-45)-55] machine occupies a special place among PGPA modifications which are intended for underground gas storage stations. The methodology which VNIIGaz developed for creating wide-spectrum PGPA's, which will permit a valid choice of the compressor part of transfer-pumping machines whose cylinders are equipped with deep regulation devices, has permitted domestic compressors which can effectively operate at substantial changes in pressure to go into production.

Compressor units of this type were developed for a number of gas-industry facilities, including PKhG stations.

MK8/[46-(67-103)]:[(23-43)-55] units were intended primarily for the underground gas reservoir at Opary. The technological parameters of operation of the Oparino PKhG station were determined by the following operating regimes of these machines:

For injecting gas into a reservoir p_{vs} = 46 kilograms-force/cm^2, p_{nag} [delivery] = 67-103 kilograms-force/cm^2, productivity of the KS is from 9.4 to 15.9 million cubic meters per day; and

For withdrawing gas from a reservoir p_{vkh} [intake] = 23-43 kilograms-force/cm^2, p_{nag} = 56 kilograms-force/cm^2, station productivity is from 7.7 to 21.3 million cubic meters per day.

In solving the problem of insuring normal operation of the Opary PKhG station, the following possible variants for equipping it were examined:

1) The erection of two pumping departments, where 17 MK8/(48-50)-(125-150) GMK machines operate in the department for injecting gas into the reservoir, and 11 MK8/(25-43)-56 GMK machines operate in the department which withdraws gas from the reservoir; or

2) A variant with the use of a single modification of the MK8/[46-(67-103)]:[(23-43)-55] GMK which can both inject and withdraw gas. The total number of such machines is 17, which is 11 fewer than under the first variant [2].

The normal operation of MK8 GMK machines for all technological regimes at suction and delivery pressures during injection and withdrawal is provided for by the manipulation of individual chambers of the compressor cylinders. Moreover, these units are widely regulated in crankshaft rotating frequency (from 220 to 300 per minute). In combination, the above-enumerated methods of regulation are responsible for effective operation of MK8/[46-(67-103)]:[(23-43)-55] machines at newly created PKhG's where the withdrawal and injection of gas into the reservoir are required.

It should be recommended that machines be created with increased unit capacity which will enable gas compression both during injection and withdrawal at the following parameters:

The injection regime—p_{vkh} = 40–75 kilograms-force/cm^2 and p_{nag} = 120–200 kilograms-force/cm^2; and

The withdrawal regime—p_{vkh} = 25–52 kilograms-force/cm^2, p_{nag} = 56–76 kilograms-force/cm^2.

DR12 gas-driven compressors primarily should be considered for such units. The following positive qualities are inherent in these transfer-pumping machines (5,500 kVt):

The capability to operate over a broad spectrum of pressure increase steps (from 1.1 to 2.7 or more) with high efficiency as both a compressor and a motor part;

High fuel economy of the GMK (motor efficiency is about 37 percent) which provides for an annual saving of fuel gas (comparable with modern gas turbines) in the amount of 7.5–8.0 million cubic meters per GMK;

The capability to provide for high absolute delivery pressure;

A high degree of automation;

Practically complete autonomy of the GMK (no more than 5 kVt of electricity is required for operating the unit); and

The possibility of maintaining full capacity of the GMK at high outside-air temperatures (up to 35 degrees C), which is of great importance for the country's southern regions.

It should be noted at the same time that the DR12-type GMK is heavy—270 tons. The weight of the heaviest assembly in its container (the assembled framework) is 66 tons. It is most desirable to use these machines at PhKG stations which require a machine for injection and withdrawal of the gas and also at large PKhG KS's (with a power of more than 15–20 kVt), which operate only during the injection period.

The use of DR12 units at large underground gas reservoir KS's will enable the number of installed machines to be sharply reduced (to one-fifth to one-sixth in comparison with 10GKN GMK's and to one-third in comparison with MK8 GMK's) with a corresponding simplification of the manifold and a reduction of the number of shutoff fixtures (stopcocks), which greatly facilitates KS operation and increases their operating reliability. For example, at PKhG stations of 30 120 kVt capacity, it is sufficient to install 6 DR12 GMK machines instead of 34 10GK and 10GKN GMK machines. During the Tenth Five-Year Plan DR12 type units will be installed at a number of PKhG stations.

In previously conducted work VNIIGaz indicated [3] the technical and economic desirability of using electric-drive GPA's at PKhG stations which

operate in areas with developed industrial electric-supply systems for 5-6 months per year (the usual time of operation—the summer period—for underground reservoirs, which require only the injection of gas into the bed).

The economic advantages of electric-drive GPA's under these circumstances are explained by the following factors (using as an example PKhG stations with an active injectable gas volume of 1 billion cubic meters, where the installation of four electric-drive GPA's with unit capacity of 4,000 kVt or eight MK8 GMK's are required):

A reduction of capital investment in erecting a KS with electric drive (the internal source of electricity is considered) by 9.3 percent;

A reduction of adjusted expenditures by 8.2 percent; and

A reduction of consumption of gas for producing power for the KS by 22.2 percent.

Moreover, the use of electricity instead of gas for KS operation provides for:

An opportunity to use energy which can be generated by various types of fuel (water, coal and others) instead of gas;

Simplification of KS tending and a reduction in manning;

A reduction of repair-work costs;

A reduction of noise and heat release by the KS;

The elimination of the requirement for water for technological needs; and

An increase in KS reliability.

It should be noted that the KS of a PKhG which injects gas into a bed requires electricity only in the warm (summer) period of the year, when a reduction in power-system loads is observed.

The development of PKhG stations with electric drive GPA's which should operate throughout the year (the second group of PKhG KS's) is economically desirable in view of the high operating costs associated with the requirement for costly electricity.

In some cases a composite buildup of PKhG stations with gas transfer-pumping units of various types (GMK's and electric-drive units, centrifugal pressure-pumping units with gas-turbine drive and electric-drive units, and so on) is possible. In such station-operation schemes, it is desirable to use 4M25/(35-44)-56 or 6M25/(35-40)-(55-75) electrical-drive machines, which also should not be operated for more than 6 months per year, as "withdrawal regime" machines.

In the long term it is possible to use GPA's at PKhG stations which are similar in configuration to electric-drive units but which use a gas DBS [internal combustion engine] instead of an electric motor. Such machines of the piston type are widely used abroad and have analogies in domestic practice.

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EFFECT OF WATER SATURATION ON GAS-RESERVE ESTIMATE TOLD

Moscow GAZOVAYA PROMYSHLENNOST' in Russian No 5, May 77 pp 25-27

[Article by V. I. Petrenko and N. A. Kravtsov (SevKavNIIGaz [North Caucasus Scientific-Research Institute for the Gas Industry]): "The Influence of Irreducible Water Saturation on the Precision of the Evaluation of Reserves"]

[Text] The gas-condensate deposit of the Kanev field, which is confined to the sediments of the Lower Cretaceous and the Jurassic-Triassic complex, has been under development since 1958. A gas deposit was discovered in Eocene sediments here in 1957. However, the insignificant, as was supposed, amount of gas in place and the low flows of gas in comparison with the flows which were obtained from the Lower Cretaceous deposit led to the Eocene deposit's being operated periodically by single wells.

As a result of work on testing the Lower Omnian reservoirs of the Eocene which Kuban'gazprom [Gas Production Association of the Kuban'] did at the start of the 1970's, the sizes of the deposits and of the gas reserves in three horizons have been refined. According to the later evaluation, gas reserves are 13.2 billion cubic meters. All three deposits have been under intensive operation since 1973, and on 1 January 1977 total gas withdrawal was 3.1 billion cubic meters.

A feature of the Eocene reservoirs is their high irreducible water saturation (see table).

Gas Saturation and Water Saturation of Eocene Reservoirs of the Kanev Field

Horizon	Gas Saturation %	Water Saturation %
I	38	62
II	35	65
III	32	68

At most Kuban gas-condensate fields which are confined to reservoirs of the Lower Cretaceous, an elastic water-drive regime is appearing. Application of the hydrochemical method has been adopted most widely as a basis for monitoring possible migration of the contour in the Eocene gas beds. This method has permitted the

the discovery of certain consistencies in changes in mineralization of the recovered water which were associated with processes which were occurring in the gas bed.

It was observed that, regardless of the location of the operating wells on the structure, they gave water of increased mineralization. In order to find out the causes of the inflow of this water, a number of correlational dependencies of the chlorine-ion content were analyzed as a function of various factors.

Research indicated that the chlorine-ion content in the recovered water was reduced as the distance from the middle of the filter prior to the GVK [gas-water surface] increased (figure 1). The dependence of the chlorine-ion content in the water as a function of the time of introduction of the wells into operation was noted. The longer the well had been operated prior to the date of the sampling, the less the mineralization of the water by chlorine ions. Also noted was a reduction of the content of the latter in water for the wells with increase in total gas withdrawal. There was no correlational connection among the water's chlorine-ion content, gas flow and increase in well depression.

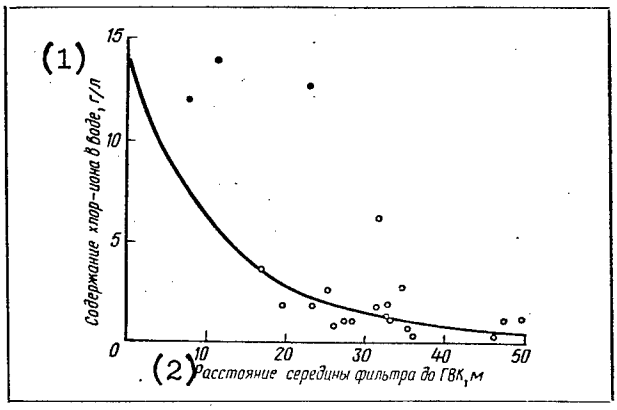

Figure 1. Chlorine-Ion Content in Recovered Water as a Function of Distance from the Middle of the Filter to the Gas-Water Contact.

Key:

- o. Wells not encroached by water.
- •. Water-encroached wells.
- 1. Chlorine-ion content in the water, grams per liter.
- 2. Distance from the middle of the filter to the GVK [gas-water contact], in meters.

The consistencies discovered can be explained by removal of capillary and loosely interstitial water from the spreading zone of the depressional funnel around each operational well, which is also confirmed by the actual moisture content of the recovered gas (figure 2).

After a well is put into operation, there is a maximum amount of recovery of capillary and loosely interstitial, highly mineralized irreducible water which is marked by an increase in its chlorine-ion content. Therefore, as the irreducible moisture saturation decreases, the chlorine-ion content in the recovered water is reduced.

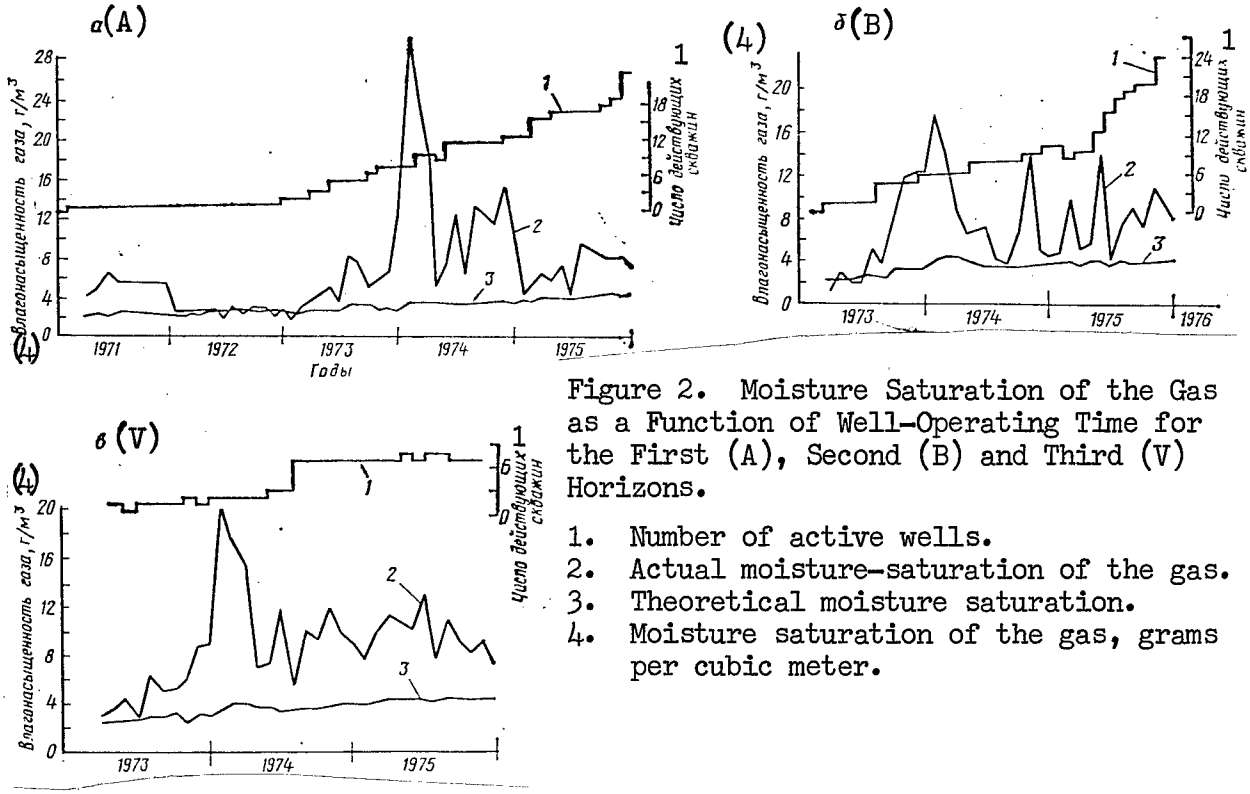

Figure 2. Moisture Saturation of the Gas as a Function of Well-Operating Time for the First (A), Second (B) and Third (V) Horizons.

1. Number of active wells.
2. Actual moisture-saturation of the gas.
3. Theoretical moisture saturation.
4. Moisture saturation of the gas, grams per cubic meter.

Thus it can be confirmed that the effective interstitial space increases in the spreading zone of the depressional funnel in the Eocene beds through a reduction in water saturation.

If gas saturation of the pores increases during operation of the bed, then from the equation of material balance and the equation of state one can find

$$\overline{p}_t = \frac{V_н}{V_t}(1 - \overline{Q}_t);$$
$$\overline{p}_t = \frac{p_t z_н}{p_н z_t};\ \overline{Q}_t = \frac{Q_t}{Q_н}, \qquad (1)$$

where V is the gas-saturated pore volume; p is the weighted-mean pressure for V; z is the weighted mean coefficient of supercompressibility for V; Q_t is the amount of gas recovered during the time t; and $Q_н$ are the initial gas reserves.

It is obvious that the deviation from the linear function $\overline{p}_t = \overline{p}_t(Q_t)$ will be determined completely by change in the value of V_t. In the case of an absence of intrusive formation water, formula (1) takes the form

$$\bar{p}_t = \frac{\alpha_H}{\alpha_t}(1 - \bar{Q}_t) \qquad (2)$$

and the relative deviation of pressure is determined from the linear function by the expression

$$\delta\bar{p} = 1 - \frac{\alpha_H}{\alpha_t}, \qquad (3)$$

where α is the weighted mean gas saturation.

It is apparent from formula (3) that, given equal pore volume and an equal amount of irreducible water carried off to the surface, the greater the $\delta\bar{p}$, the greater the initial gas saturation. If it is considered that where $\alpha_H < 0.7$ the irreducible water takes an active part in filtration, then an assumption can be made about a substantial deviation from the linear function $\bar{p}_t = \bar{p}_t(Q_t)$. Thus, where $\alpha_H = 0.5$ and $\alpha_t = 0.51$, $\delta\bar{p} = 0.02$. A deviation of 2 percent can be completely discerned by modern measuring instruments.

It should be noted that the original points on the graph of $\bar{p}_t = \bar{p}_t(Q_t)$, within the limits of precision of measurement and of graph construction lie on a straight line which passes below the straight line where $\alpha_t = \alpha_H$. Thus, this leads to an incorrect determination of the bed's operating regime and to an understated determination of the initial reserves, which are determined according to the pressure-drop method. In so doing, the earlier that α_t reaches maximum value, the greater the error in Q_H. Thus, where $\bar{Q}_t = 0.2$ and $\delta\bar{p}_{max} = 0.02$, the Q_H error reaches 10 percent, and where $\bar{Q}_t = 0.1$ and with the previous α_t, the Q_H error is 20 percent.

Conclusions

1. The development of gas beds which are confined to reservoirs with high irreducible water saturation leads to a partial removal of capillary and loosely interstitial water, an increase in the gas-saturation coefficient of the pore space and an increase in the depth of the depressional funnel in the gas withdrawal zone.

2. Where there is a substantial withdrawal of irreducible water during the initial stage of development, deviations of p/z—a function of the gas-regime curve with regard to reduction in gas reserves—are possible.

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PETROLEUM, GAS EXPLORATION TASKS

Moscow NEFTEGAZOVAYA GEOLOGIYA I GEOFIZIKA in Russian No 5, May 77 pp 6-9

[Article by S. P. Maksimov, N. I. Buyalov, G. Kh. Dikenshteyn, and V. V. Pechnikov (VNIGNI): "Basic Tasks of Development of Petroleum and Gas Geological Exploration Work"]

[Text] The historic decisions of the 25th CPSU Congress are of enormous importance to the further development of our country's petroleum and gas producing industry. Large tasks with respect to stepping up the increase of industrial reserves of petroleum and gas insuring the level of recovery of these valuable minerals stipulated for the Tenth Five-Year Plan and the long term future were also assigned by the 25th Congress to the geological service.

Of vital importance is the task of improving the economic effectiveness of geological exploration work. A vital role in resolving this problem belongs to petroleum and gas geological science and the scientific substantiation of the most promising directions in petroleum and gas prospecting-exploration work.

Satisfying the country's ever-increasing need for petroleum and gas requires increasing the volume of recovery and, consequently, accelerated preparation of explored reserves--especially in regions having a highly developed and developing petroleum and gas producing industry. At the same time, it is essential to step up the study of the prospects of petroleum and gas bearing territories now in the initial stage of geological investigation.

For the regional geological investigations and prospecting-exploration work for petroleum and gas in 1971 through 1975 an average of 355 structures were introduced every year.

Petroleum and gas geological exploration work was concentrated as follows:

in the most promising regions of the Western Siberian, Timano-Pechorskaya, and Amudar'inskaya Petroleum and Gas Bearing Provinces, where petroleum and gas deposits have been discovered earlier, and where high effectiveness of geological exploration work was expected;

in the petroleum and gas producing regions of the Northern and Southern Ural-Volga region, the Ukraine, the North Caucasus, the Transcaucasus, and Kazakhstan, where geological exploration work was carried out under complex geological conditions--in studying deep-lying promising deposits as well as prospecting petroleum and gas deposits in stratigraphic petering-out traps and lithological rock displacement traps;

in the marginal zone of the Caspian Depression, promising regions of Eastern Siberia, the Far East, and offshore shelf zones.

Among the most important results of geological exploration work in the last 5-year period mention should be made of the expansion of the raw materials base of the petroleum producing industry in Western Siberia, the further expansion of prospects in the Timano-Pechorskaya petroleum and gas province, the obtaining of new data confirming the high forecast evaluations of the Orenburg and Perm' regions of the Volga-Ural province, and also a number of areas in western Uzbekistan, eastern Turkmenia, the Ukraine, and Kazakhstan.

An analysis of the results of prospecting-exploration work has shown that plans for increasing reserves of petroleum and gas are regularly being fulfilled in regions having a medium level of geological investigation, also in regions for which we have adequately reliable ideas about the regional tectonic structure and the petroleum and gas bearing properties of promising objects of prospecting. We may assign to this group of regions, in particular, the Western Siberian and Timano-Pechorskaya petroleum and gas bearing provinces, in which a high effectiveness of geological exploration work has been achieved.

The effectiveness of operations has declined somewhat in the European part of the country. Throughout the country as a whole, the effectiveness of geological exploration work during the Ninth Five-Year Plan was rather high.

As before, in all regions great importance attaches to strengthening regional investigations which determine the intensity of implementation of subsequent stages of geological exploration work and the degree of their effectiveness. An analysis of the dynamics of regional operations in the last 15 years shows that in many areas regional operations--especially orientation and parametric drilling--were inadequate and lagging behind schedule.

During the Eighthand Ninth 5-Year Plans the main volumes of parametric drilling were carried out in regions having a high level of geological investigation. The developing regions and areas in the initial stage of investigation accounted for a relatively low volume of parametric drilling.

Underestimation of the importance of regional investigations has led to a decline in the effectiveness of preparation of reserves and made it difficult to determine the most promising directions in geological exploration work, also the planning of increased petroleum and gas reserves. This occurred, for example, in prospecting drilling into subsalt deposits in the Caspian

Depression, in the study of Devonian deposits in southern Orenburgskaya Oblast, and so on. At the present time, the problem of promising petroleum prospecting in the northern part of the Western Siberian province remains inadequately studied.

The effectiveness of geological exploration work has been affected by a certain amount of lagging in the field of preparing an adequate inventory of structures of the anticlinial and nonanticlinial type at moderate depths. In connection with this, it is necessary to orient prospecting drilling toward the prospecting of petroleum and gas deposits in deep lying traps; this leads to substantial increases in costs and slower drilling operations.

Between 1965 and 1975 the average depths of wells in the country increased from 2,195 to 2,775 meters. Depths rose most noticeably in the Timano-Pechorskaya petroleum and gas bearing province, the Ukraine, and Belorussia. Even in Western Siberia, where for a long time the average well depths remained practically unchanged, in the last 5-year period they went considerably deeper. A similar situation is observed in the southern regions of the country. Average well depths increased substantially in the Ciscaucasus and in the southern part of Central Asia. Throughout the country as a whole in 1971 through 1975, 34 percent of the completed well drilling went down deeper than 3,000 meters. The increase in the average well depths had an adverse effect on drilling's technical-economic indicators. Despite improvements in drilling equipment and the technology of well drilling, schedule drilling speeds have either stabilized or even declined with the increase in depths.

In connection with this, capital investments in drilling rose by more than 160 percent during that period.

Attention must be focused on the large number of unproductive wells. Although their percentage declined, it continues to remain rather high.

The increased complexity of geological conditions in prospecting petroleum and gas deposits has required the strengthening of the complex of regional and detailed geophysical operations; this has entailed increased state budget appropriations for implementing this work.

The decisions of the 25th CPSU Congress set forth the specific tasks with regard to the further development of the petroleum and gas industry in 1976 through 1980, and special attention is focused on speeding up the preparation of the raw materials base.

It is possible to implement these tasks while maintaining high economic effectiveness only by concentrating scientific research on the most important directions, taking account of the current level of world scientific-technical progress. An analysis of the results of prospecting-exploration work during the Ninth Five-Year Plan makes it possible to delineate three groups of promising territories in this country.

Assigned to group one are the highly promising territories: Western Siberia, Central Asia, the Timano-Pechorskaya petroleum province, and the Caspian syneclise, where broad development of further petroleum and gas prospecting-exploration work is essential.

Assigned to group two are the promising but poorly-studied territories: Eastern Siberia, the Far East (in particular, the territory of the Yakut ASSR and Sakhalin), which require a large amount of regional work.

Assigned to group three are the so-called "old regions" having a highly developed petroleum and gas producing industry (Azerbaydzhan, the North Caucasus, the western oblasts of the Ukraine, Western Kazakhstan, Western Turkmenia, and the Volga-Ural Province), in which the main deposits and fields have already been discovered and have for the most part been thoroughly worked out. Nevertheless, the ground in these regions still contains undiscovered deposits of petroleum and gas in poorly-studied portions of the profile. The main prospects here are related to Mesozoic deposits in Azerbaydzhan, Triassic deposits in the North Caucasus, the subthrust in the Capathians, the subsalt deposits of the Emba fields, the Mesozoic and Paleozoic deposits of Western Turkmenia, and the lower portion of the Paleozoic profile of the Volga-Ural province.

At the present time, highest priority must be accorded group one of the territories, by which it will be possible to completely insure the basic increase in reserves during the current 5-year plan and the near future. A very important reserve for the preparation of petroleum reserves is group two, where it is essential to concentrate primarily regional work for purposes of preparing objects for prospecting-exploratory drilling.

The results of studying the mineral deposits of the Soviet Union in recent years--especially the Ninth Five-Year Plan--have made it possible to generalize materials on the geological structure of various areas in the country and, on this basis, to determine ways to further develop scientific research in the field of prospecting-exploration work. Not enough attention is being focused yet on problems of the specific and integrated study of individual deposits of fields and petroleum and gas accumulation zones.

It is essential to step up the scientific development of new methods and the perfecting of existing methods of prospecting-exploration work at all stages of implementation.

It is essential to focus attention on improving the quality and effectiveness of prospecting-exploration work, on improving all technical-economic indicators relating to petroleum and gas prospecting and exploration. It is essential to make more extensive use of computers in prospecting-exploration work, and also mathematical methods.

One of the most important and high-priority tasks of scientific research in 1976 through 1990 is the formulation of the theoretical principles of improving the effectiveness of geological exploration work for petroleum and gas. To accomplish this goal it is essential: to substantially step up research into the predictive evaluation of the petroleum and gas potential of large regions of the USSR, to increase their reliability and to determine scientifically substantiated directions of petroleum and gas prospecting and exploration work; to step up the volume of research into the study of processes of petroleum and gas formation and the formation of petroleum and gas deposits, which must be directed primarily toward determining criteria for evaluating the prospects of the petroleum and gas potential of regions in terms of the composition of the organic matter of the rock, the petroleum and gas, and the stratal water, using the most up-to-date methods; to increase the scale of procedural investigations relating to the prospecting and exploration of petroleum and gas deposits under various geological conditions, orienting these efforts toward improving the reliability of the preparation of local structures prior to subjecting them to deep drilling; to step up efforts aimed at further improving the resolution capacity of geophysical methods for the study of structures under complex geological-geophysical conditions, also at perfecting a complex of production field-geophysical investigations of petroleum and gas wells; to work out a methodology of prospecting and exploring lithological and stratographic petroleum and gas deposits; to adopt mathematical methods more widely for processing geological information in the forecasting of the prospects of petroleum and gas potentials and further directions of petroleum and gas geological exploration work; to work out the scientific principles for improving the effectiveness of the preparation of industrial petroleum and gas reserves in specific petroleum and gas provinces and areas; to step up the comprehensive study of carbonate collector rocks containing substantial reserves of petroleum and gas; to substantially boost the volume of geological-economic investigations aimed primarily toward determining ways of improving the economic effectiveness of geological exploration work in various regions of the USSR.

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NATURAL GAS IN CRYSTALLINE FORM

Moscow TEKHNIKA I NAUKA in Russian No 5, May 77 p 17

[Article: "A New Raw Material: Solid Gas"]

[Text] The earth's crust still contains many astonishing things. For example, research by scientists in Yakutia shows that the earth of Siberia, which includes the famous Tyumen' area, contains such exotic substances as deposits containing natural gas in the solid phase. Naturally, this is interesting by itself, but the study of this problem is not an end in itself. Some specialists believe that such deposits, known as gas hydrate deposits, can be worked and yield benefits to the national economy. In short, this involves a very promising raw material for the fuel and chemical industry.

An entire complex of work is going on in the Institute of Physical-Technical Problems of the North of the Yakut branch of the Siberian Department of the USSR Academy of Sciences. It was there that the idea came into being of prospecting for solid gas in regions of permafrost; scientists there predicted the depth of gas hydrate deposits and worked out procedures for their geological exploration and exploitation. Naturally, recovering solid gas is no simple matter. There are still many complex technical problems.

But where to look for it? Scientists concluded that it must surely be located in the permafrost stratum. It is interesting to note that gas in crystalline form was first discovered in...a plexiglas tumbler--that is, in a laboratory. It was produced during the course of an experiment designed to model conditions of deep-lying layers where super cooled stratal water comes into contact with methane and other hydrocarbons. Later on, actual gas hydrate deposits were discovered in some regions of Siberia at depths ranging between 200 and 900 meters. This brilliantly confirmed the theoretical assertions of the scientists of Yakutia. Now their concern is to make practical recommendations to production workers.

PHOTO CAPTION

Crystal particles resembling crushed ice but in reality solid gas.

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FISH RESOURCES AND FISHING INDUSTRY IN BELORUSSIA

Moscow SEL'SKAYA ZHIZN' in Russian 26 Apr 77 p 2

[Article by V. Belyayev, chief of the Administration of Fish Industry attached to the BSSR Council of Ministers: "In the Mirror of Ponds"]

[Text] Belorussia has more than 600 lakes with a total surface of 118,000 hectares and 15,000 hectares of ponds. Ten years ago a total of only 46,300 quintals of fish were extracted from these waters, and the share taken from ponds constituted one-half of this quantity. However, while the average catch from one hectare of pond water surface was 4.6 quintals of fish, in the lakes it was only 12.1 kg.

The fish industry of the republic began to develop at an accelerated pace in the Eighth Five-Year Plan, when over 5,600 hectares of fattening ponds and 1,700 hectares of hatchery ponds were put into operation. Natural reservoirs were stocked with more than 80 million young of valuable fish types, such as eel, carp and sazan. In consequence the gross fish catch almost tripled. The production of pond fish, which at present constitutes more than 80 percent of the total volume, increased fourfold. The harvest from each hectare of pond water surface reached 10.7 quintals.

In the current quinquennium, as also in the preceding years, the leading role will be assigned to pond fish-raising. The production of pond fish will grow by 175 percent during the years of the Tenth Five-Year Plan, and by 1980 the annual catch will be at least 170,000 quintals. This is more than is envisaged by the five-year plan. The main road to the fulfillment of this goal is to raise the productivity of ponds. In the existing enterprises the "harvest" should reach 16.5 quintals per hectare of water surface by 1980.

Practice shows that for Belorussian fish-breeders such indicators are not the limit. Even last year, which was a very difficult one with regard to weather conditions, many brigades and production sections exceeded the designated program. For instance, the brigade of the Beloye Fishery Combine headed by Mikhail Yaroshik obtained 19.8 quintals of fish per hectare. Workers Nikolai Kolosov and Ivan Kandora of the Krasnaya Zor'ka Fishery Combine raised up to 17.8 quintals of fish, and the catch on individual ponds of the Lakhva Fishery Collective amounted to 20-25 quintals per hectare.

Unfortunately, such results are not attained by all collectives. Quite a number of serious problems exist which make difficult the rapid development of the sector. It is a well known fact that in order that fish may grow well and reach the planned weight increase, it must be fed. Nonetheless fish-breeders are still awaiting from science and the mixed-feed industry feeds which would not immediately dissolve in water and which would contain the entire range of the necessary components -- particularly, animal proteins, amino-acids and vitamins.

In a number of instances enterprises in pursuit of larger plans do not execute timely prophylactic and sanitary measures on the ponds. Also, we receive inadequate aid from science in the struggle with fish diseases.

In order to raise the efficiency of pond fish-breeding, it is necessary to be concerned also with a substantial improvement in the technical equipment of enterprises. Our fish-breeding units are not sufficiently supplied, for instance, with equipment for pond reconstruction, for the application of mineral fertilizers, and for the catching of fish.

One of the most important reserves is more intensive utilization of the fishery potential of rivers and lakes. Their natural productivity is low, and the share of such valuable varieties of fish as pike-perch, carp-bream and catfish is small. The whitefish and the vendace have disappeared from rivers and lakes. At the same time the number of low-value fish -- such as the roach, perch and ruff -- has increased. It must be admitted that the fault is our own. For a long time the fishery organizations relied mainly on the natural reproduction of fish stocks, and even when they did conduct restocking of the lakes, it was without the necessary preparatory operations. As a result, a large part of the fledgling stock set out there fell prey to the teeth of predators. Moreover, the existing regulations on fishing in small lakes are conducive to the reduction in the quantity of low-value and nuisance varieties of fish, whose elimination is furthered neither by the length of the fishing season nor by the mesh-size of the sweep-nets employed.

In the Tenth Five-Year Plan we tasked ourselves with raising the working standards of the sector and with maximal utilization of each hectare of natural reservoirs. We are beginning to conduct their exploitation on the principles of the pond fishery. A few years ago, for instance, the stocking of Lake Beloye at the Berezovskaya GRES was begun. About 140,000 two-year old amur and silver carp were set out there. In 1975, 160 quintals of fish were caught in this lake -- about 40 kg per hectare. Last year, the catch was already 350 quintals, or 86 kg per hectare. The average weight of herbivorous fish reached 7-8 kg and of some specimens 10-15 kg. Without preparation and fish-stocking, the yield per hectare of the reservoir did not exceed 10 kg.

Taking into account the experience of the Tyumen' fish-breeders, we have decided to transfer by 1980 to a commercial fish-breeding regime 38,600 hectares of lakes and to raise their productivity to 60 kg per hectare. Already now the Vitebsk, Braslavsk, Polotsk and Narochansk fishery plants have been transformed into commercial lake operations. On the site of the Lukoml 'skoye Experimental Commercial Organization and the Lukoml' Fish Hatchery we are founding a Novolukoml'sk Fish Farm where we will try to acclimatize and breed new valuable fish varieties -- bester, buffalo, channel catfish, trout, and eel. Within the structure of the Pinsk Fishery Plant, the Krasnopolessk Lake Commercial Fishery will be founded as a department of an economic accountability basis.

We are not talking about a mere renaming of fishery plants into commercial lake fisheries, but about a fundamental restructuring of their work. The main task is to found a stable base for the production of high-quality stocking material and, on this foundation, to raise sharply the productivity of natural reservoirs and to increase the fish catch. We count on raising the production of fingerlings of valuable fish varieties to 135 million fish by the end of the five-year plan period -- almost twice more than was raised in the republic in 1975. Out of this number, at least 125 million young will be set out into natural water reservoirs -- approximately four times as much as during the last five-year plan period. During the last year alone 6.7 million fry of glassy eel, pelyad, buffalo and trout were set out in the reservoirs of the republic, as well as 300 reproducing males of herbivorous fish species. Beyond that, 2.8 million carp, sazan and crucian carp were deposited.

This spring the Lukoml'sk Fish Hatchery will begin to operate a plant designed for the incubation of 150 million eggs of carp and plant-eating fish. The application of industrial methods for the production of young fish is expanding also in other organizations. Altogether we plan to derive this spring at least half of the total output of fish-stocking material by artificial methods. We are devoting special attention to the incubation of the roe of pelyad, herbivorous fish, trout, carp and pike with subsequent raising of hardy fry in tanks and troughs. This will make it easier to provision both pond and lake fisheries with fish-stocking materials and to raise sharply the production of carp, herbivorous fish, pike and trout.

Issues connected with the creation of a reliable commercial fishing fleet are more complicated to solve. It is difficult to obtain small motorized vessels of 20-40 horsepower capacity, which are the most suitable for internal water reservoirs, as their production has not been organized. In the construction of fishing equipment and the organization of commercial fishing, the assistance of local experts has to be used. But if the fishing organizations had a modern, highly mechanized fleet and improved equipment for fishing in small lakes, the efficiency of the branch would be a good deal higher. Efficient utilization of the resources which are at the disposal of the local water reservoirs should be reflected in the thematical plans of scientific research institutes and planning organizations.

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ECONOMICO-MATHEMATICAL METHODS OF PLANNING LABOR INDICATORS

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[Article by I. Denisenko, chief specialist of USSR Gosplan: "Economico-Mathematical Methods in the Planning of Labor Indicators"*]

[Text] In order to take into account the dynamic factors of economic growth in long-range and intermediate planning of labor productivity, an indicator such as capital-labor ratio (machine-labor ratio) is needed.

Without resolving the correlational problems it does not seem feasible to use the capital-labor ratio indicator as the growth factor of labor productivity in the planned period, because prior to determining the capital-labor ratio one ought to calculate the unknown number of workers in the planned production and the productivity of labor. Besides, the experience of developing the ASPR [Automated Control Systems of Planned Calculations] has shown that the usual methods of direct calculation of the indicators of the plan--used during manual processing of information--withstand translation into the machine language of automated control systems (ASU) in order to solve optimizational problems. That is why, during the past five-year period in the block "Labor" of the ASPR subsystem "Labor and Personnel" not a single economico-mathematical problem of the plan was solved. It is possible to develop models for automated control systems only by way of improving the methods of planning which are based on the integral (generalizing) system of information processing, permitting to use economico-mathematical methods and electronic computers.

For the planning (forecasting) of the number of workers in the industries we recommend an economico-mathematical model which looks like a power function:

$$L_i = aQ_i^{\alpha}K_i^{\beta}. \qquad (1)$$

*As a matter for discussion

But in this case (without its modification) only the already formed regularities in the development of the factors of labor productivity growth of the past period can be calculated. These regularities, determined on the basis of indicators analyzed over 10-20 years of the past period, do not reflect the new tendencies of scientific and technical progress of the planned period. At the same time the time multiplier $e^{\lambda t}$ (λ --constant in the variable of real time t, e--basis of natural logarithms), usually introduced in multifactorial models of labor productivity forecasts as an indicator of technical progress, solves the problem only partially. Calculations, conducted by us up to 1990 in a number of associations and enterprises of the automotive industry, have shown that the share of influence of the time multiplier on the increase of labor productivity is insignificant: 0.6-3 percent of the projected for the future growth of labor productivity.

Therefore, we propose to introduce into the function (1) a correction factor W which takes into consideration the acceleration of scientific and technical progress of the planned period, and when using it on the level of enterprises make it look as follows:

$$L_t = aQ_t^{\alpha} K_t^{\beta W}, \tag{2}$$

and on the macroeconomic level of large branches (ministries) and industry as a whole, requiring high inputs of materials in production, the model will look like

$$L_t = aQ^{\alpha} K_t^{\beta} W_t. \tag{3}$$

Where L--number of personnel in industrial production;

Q--volume of output;

K--fixed producer goods;

a--parameter of proportionality and effectiveness of resources;

α--parameter of equation $\left(\frac{\Delta L}{L} : \frac{\Delta Q}{Q}\right)$ — ratio between the rates of increment in the number of workers engaged and the rates of increment in the volume of output);

β--parameter of equation $\left(\frac{\Delta L}{L} : \frac{\Delta K}{K}\right)$ — ratio between the rates of increase in the number of workers engaged and the rates of increase of fixed producer goods);

W--correction, reflecting the economy of the work force at the expense of the acceleration of scientific and technical progress in the planned period;

t--past and prospective periods, years.

The correction factor W is determined in the function as a proper fraction, i.e. $1 \geqslant W \geqslant 0$. Its purpose--reduction of the number of workers in the planned volume of output. Therefore, if, for example, parameter β is positive, it is multiplied by W; if negative, it is divided by W.

The distinctive feature of factor W consists in that there is no initial information for its calculation in statistical records. In this case planned projections of the growth of fixed producer goods, of the increase of unit capacity (productivity) of new machines and equipment, and so forth are used.

The meaning of W permits to tie-in indicators of the plan and of the forecast, improve the method of extrapolation, ensure optimizational projected calculations of labor expenditure for the planned volume of output and the growth rates of labor productivity which are based on the requirements of the plan in respect to the scientific and technical progress and intensification of production.

At the same time, when forecasting the growth rates of labor productivity, it is necessary to improve the method of extrapolation by way of replacing the conventional time multiplier $e^{\lambda t}$ with the correction factor W:

$$W = 1 - \frac{m}{L_0 + \Delta L}, \qquad (4)$$

where $m = \Delta L{:}h$--relative economy of the number of workers caused by the influence of the scientific and technical progress;

ΔL--increase in the number of workers, calculated according to formula (1), under the existing in the period under review rates of growth of technical progress;

h--average weighted coefficient of the increase of unit capacity (productivity) of the means of labor or the rate of growth of the active part of producer goods;

L_o--average listed number of production-industrial personnel of the base period.

Parameter h serves as a criterion of optimality which reflects the increase of labor productivity, resulting from the reduction of living labor expenditure for a unit of output.

When introducing real corrections in the results, received during forecasting by the method of extrapolation, it is necessary to determine the average weighted coefficient of increase of the unit capacity and productivity of the means of labor, marked h.

We propose a methodical approach to the evaluation of the system of normative coefficients of fixed capital renewal. The latter reflects the effectiveness of measures of the scientific and technical progress, outlined in the longrange and intermediate plans. In the perspective period, growth of the active part of fixed producer goods (machines and equipment) calculated for one worker will be accompanied by an increase in the application of new in principle means of labor, by the creation and expansion of automated power and metallurgical aggregates, by higher unit capacity of oil refining, chemical, and petrochemical equipment and transport means which ensure the growth of labor productivity by several times.

The problem of complex mechanization and automation of the production processes has two sides: economic, i.e., increase of labor productivity, and social--reduction of hard manual labor.

The reduction of the relative share of manual labor in the industries, outlined in the Tenth Five-Year Plan, is connected with the increase of the share of production of the means of mechanization in the total volume of machine-building output, and also with the expansion of the products list of new, more productive machines and mechanisms whose application increases labor productivity 2.5-3.0 times at a given work place.

Calculations according to consolidated norms show that with minimal periods of return from fixed capital of 2.5 years, it is necessary to produce approximately 6 million rubles' worth of highly productive material-handling equipment and other means of mechanization in industry in order to release 1,000 workers, engaged in hard labor. At the same time, realization of these measures permits to substantially reduce the share of hard manual labor and to ensure on the average nearly 20 percent of the total increase of labor productivity in a given sector.

In order to determine the average weighted coefficient of unit capacity h, it is necessary to work out a system of coefficients and norms, reflecting the quantitative evaluation of the individual factors of technical progress which influence the increase of labor productivity at the enterprises of industries with physical production. Calculation of the increase in the aggregate capacity of new equipment in machine building and metal working is the most complicated, because in order to do this it is necessary to have not only the relative share of highly productive equipment, but also

the quantity of new machine tools of different types with comparative characteristics of their productivity. As a result of improvement of the structure of the machine tool park the quantity of highly productive mechanized flow lines has increased 2 times during 1966-1970; of automated lines, 1.5 times; of special, specialized, and aggregate machines, 3.5 times during 1951-1970; and of grinders, 4 times.

The Experimental Scientific Research Institute of Metal-Cutting Machine Tools (ENIMS) has done a great deal of work in calculating the norms in respect to the productivity of the machine tool park. For comparison with new, more productive machine tools the coefficient of old equipment was taken as 1, universal modernized machine tools--with a coefficient of labor productivity as 1.1; universal new, as 1.2; automatic and semiautomatic, as 3, special and specialized machine tools, as 4; aggregate machine tools, as 6; with numerical program control, as 8; automatic and semiautomatic lines, as 10.

Using these norms, we have determined (by way of multiplying the quantity of machine tools by the above productivity coefficients of individual types of equipment) the capacity of machine tools in machine building as a result of the renovation of the equipment park, anticipated by the plan for 1976-1980, as 245,000 units.* The capacity of machine tools for 1975 was calculated in the same manner.

Proceeding from this, let us make a conventional calculation for determining the growth of labor productivity of machine-tool workers: $\frac{494{,}0 \cdot 100}{416{,}2} = 118{,}7\%$. Then we calculate the coefficient of use of the active part of fixed capital which takes into account the increase of labor productivity as a result of the increase of the share of highly productive equipment:

$$K_2 = 1 + \left(\frac{\Delta n \, n_1 \, n_к}{L_0} \right) \Delta d,$$

where Δn--increment of new equipment (245,000 units);

n_1--ratio of machine tools and the number of equipment of multiple machine-tool service (0.7);

n_k--work shift coefficient of enterprises (1.7);

L_o--average listed number of workers of the industry (enterprise), where the coefficient of the renovation of the means of labor is determined (13.8 million persons);

*"Materialy XXV s"yezda KPSS" [Materials of the 25th CPSU Congress], Moscow, Politizdat, 1976, p 137.

Δ d--increase of the aggregate unit capacity (productivity) of new equipment in percent to the existing capacity (118.7).

If we substitute the initial calculations in formula (5) [as published], we will receive

$$K_2 = 1 + \frac{(245{,}0 \cdot 0{,}7 \cdot 1{,}7)}{13{,}8} 118{,}7 = 1{,}25\%.$$

The average weighted coefficient of use of the active part of producer goods (h) is calculated from the normative evaluation of the characteristics of measures of the technical progress. According to our calculations, in machine building and metal working on average for the five-year period it will constitute

$$K_1 K_2, \ldots, K_n = h - 158.$$

Coefficients, influencing the magnitude of h:

K_1 = 1.06--reflects the rate of renovation of machines and mechanisms, taking into account their improvement on the basis of new production technology and the use of highly productive cutting instruments;

K_2 = 1.25--calculates the increase of labor productivity as a result of the increase of the share of highly productive equipment and improvement of its structure in the common park of machine tools;

K_3 = 1.01--influences at the cost of the increase of the share of more productive forge and pressing equipment in the park of metal-cutting machines;

K_4 = 1.08--reflects the use of the means of mechanization and automation of manual labor;

K_5 = 1.09--calculates the increase of labor productivity, resulting from the improvement of production management and the introduction of the scientific organization of labor.

Thus, coefficient K_1 which reflects increment in the renovation of the park of metal-cutting machines, anticipated for the Tenth Five-Year Plan in the amount of 6 percent,* is the basis of the above system of coefficients of the growth of labor productivity of new equipment.

*"Materialy XXV s"yezda KPSS," p 137

Proceeding from the calculated meanings of individual normative coefficients, the average weighted coefficient of increase of the unit capacity (productivity), or the rate of growth of the active part of fixed producer goods, designated in formula (4) as h, is expressed as the product of the rates of growth of physical renovation of new machines and mechanisms and the growth of their labor productivity (149 · 106 = 158%).

Such integrated approach to the development of a system of normative coefficients of individual factors of utilization of the active part of fixed producer goods on the basis of planned introduction of new, highly productive technology in the perspective period reflects the average weighted coefficient of increase of the unit capacity (productivity) or the rates of growth of the active part of producer goods for the substantiation of perspective and current plans of an industry, association, or enterprise. Moreover, the most important condition of the calculation is the calculation of the inverse proportionality between the increase of the active part of producer goods and the increase of their productivity, because the higher the unit capacity of machines and equipment, the lower the rates of renovation of these means of labor, and vice versa.

The surpassing growth of labor productivity (149%) in comparison with the increase of the means of labor, considering their improvement (106%), characterizes better utilization of fixed producer goods and reduction of labor expenditure for a unit of output, and also is the substantiated criterion of the optimality of long-range, intermediate, and current (yearly) plans. The influence of the system of coefficients of the utilization of producer goods on the optimization, when forecasting the economic growth of production and the growth of labor productivity in the long-range plan, will contribute to orienting the industries (ministries), associations, and enterprises to make progressive decisions in the field of technical policy, when developing and fulfilling one-year and five-year plans.

In order to calculate the parameters of equation of the power function (1), we have made an analysis of statistical data on the actual meanings of L, Q, and K in industry on the whole and in machine building and metal working in comparable conditions of each year during a period of 25 years (1951-1975).

For the analysis and prognosis of workers according to five-year periods until 1990, the following matrix was used:

$L_1 L_2 L_3, \dots, L_n$ $Q_1 Q_2 Q_3, \dots, Q_n$ $K_1 K_2 K_3, \dots, K_n$	--initial information
$L = aQ^{\alpha} K^{\beta}$	--formula to calculate the parameters
$Q_{n+1} Q_{n+2} Q_{n+3}, \dots, Q_{n+m}$ $K_{n+1} K_{n+2} K_{n+3}, \dots, K_{n+m}$	--numerical meanings of the factors of forecasting
$L_{n+1} L_{n+2} L_{n+3}, \dots, L_{n+m}$	--making the problem logarithmic.

The parameters of equation of the function were determined according to the standard program in the universal language ALGOL on the electronic computer type BESM-4 according to formula (1) with the help of the method of the smallest squares with preliminary conversion of the problem into a logarithm and giving it a linear appearance. They constituted: in the industry on the whole $L = 3.6348\ Q^{0.3876}\ K^{-0.0363}$ and in machine building and metal working--$L = 2.1896\ Q^{0.4430}\ K^{-0.0994}$.

By substituting in the above models the adopted in the calculations for 1976-1980 meanings of Q and K in the industry on the whole and by making the problem logarithmic, we will receive data of the forecast number of industrial-production personnel:

$$L = \lg 3{,}6348 + 0{,}3876 \lg 720 - 0{,}0363 \lg 162;$$
$$\lg L = 0{,}5605 + 0{,}3876 \cdot 2{,}8573 - 0{,}0363 \cdot 2{,}2095;$$
$$\lg L = 0{,}5605 + 1{,}1075 - 0{,}0802;$$
$$L = \lg 1{,}5879.$$

The unknown meaning of the target function constituted: L = 38.72 million persons.

Meanings, given in Table 1, were determined in the same manner.

Table 1.

(1) Годы	(2) Промышленность в целом				(3) Машиностроение и металлообработка			
	(4) Q, млрд. руб.	(5) K, млрд. руб.	(6) L_0 по отчету, млн. чел.	(7) L_n по расчету, млн. чел.	(8) Q, млрд. руб.	(9) K, млрд. руб.	(10) L_0 по отчету, млн. чел.	(11) L по расчету, млн. чел.
1951—1955	94,7	17,3	19,0	19,1	14,0	3,5	6,2	6,2
1956—1960	157,4	30,0	22,6	22,8	26,9	5,4	7,6	7,9
1961—1965	229,0	48,0	27,1	26,7	48,6	9,8	10,0	9,8
1966—1970	373,0	74,7	31,6	30,8	88,0	16,6	12,1	12,2
1971—1975	523,0	113,3	34,0	34,6	143,0	29,4	13,8	14,1
1976—1980	720,0	162,0	-	38,7	220,0	47,0	-	16,3

Key:

1. Years
2. Industry on the whole
3. Machine building and metal working
4. Q, billion rubles
5. K, billion rubles
6. L_o according to report, million persons
7. L_n according to calculation, million persons
8. Q, billion rubles
9. K, billion rubles
10. L_o according to report, million persons
11. L according to calculation, million persons

Due to the fact that correction W is not used in this standard program yet, calculations of the number of workers were made in two stages: first the needed number of workers was calculated according to formula (1) with an electronic computer, and then the meanings of W were determined according to formula (4) by hand, using the average weighted coefficient of the increase of unit capacity (productivity) of the means of labor h:

in industry on the whole:

$$1-\frac{4{,}8:1{,}43}{34{,}0+3{,}4}=\frac{3{,}4}{37{,}4}=0{,}91;$$

in machine building and metal working:

$$1-\frac{2{,}5:1{,}58}{13{,}8+1{,}6}=\frac{1{,}6}{15{,}4}=0{,}90.$$

Taking into account the meanings of W, the projected number of industrial-production personnel (see Table 1) constituted:

in industry on the whole:

for 1976-1980, 38.7 · 0.91 35.3 million persons,

for 1981-1985, approximately 36.3 million persons, and for 1986-1990, 36.9 million persons;

in machine building and metal working respectively:

16.3 · 0.90 14.7 million persons; 15.1; and 15.8 million persons.

The requirement in the number of workers received comes close to the optimum for the fulfillment of the outlined calculated volumes of production in these industries.

Experimental calculations made by us showed almost complete correspondence of the actual and calculated number of workers for the periods under review (see Table 1), and the necessary reduction in the need for workers in the planned period.

Having the projected number of workers and the outlined rates of growth of the volumes of production available, we determined the increase of labor productivity for 1976-1980 in the industry on the whole:

$$32\%=\frac{11{,}3}{46{,}6-11{,}3}100,$$

where 46.6 (million persons)--initial number of industrial-production personnel of the planned period while keeping the base labor productivity, received by multiplying the base number of personnel by the planned volume of production (34.0 • 137);

11.3 (million persons)--relative economy of the work force, received by way of subtracting it from the initial projected number (46.6 - 35.3).

Proceeding from the projected number of workers, we determined the norm of the share of increment of output at the cost of increasing labor productivity (x), used in the perspective current planning of labor indicators:

$$x = 100 - \frac{3{,}8}{37} 100 = 90\%,$$

Magnitude [as published] 3.8 percent was determined by way of dividing the planned number of personnel by the base number of personnel:

$$3{,}8\% = \frac{35{,}3}{34{,}0} - 100.$$

Moreover, the relative share of the increase of labor productivity in its total increase at the expense of speeding up scientific and technical progress in the planned period, calculated according to formula (4), will constitute:

in industry on the whole:

$$W = \frac{3.4}{11.5} 100 = 30.0\%;$$

in machine building and metal working:

$$W = \frac{1.6}{6.7} 100 = 24\%$$

If one introduces correction W in the parameters of the production function, the projected volume of output will increase in the same amounts as the growth of labor productivity, instead of 0.6 - 3%, received with the application of the temporary multiplier ($e^{\lambda t}$).

Along with the projection of labor productivity on the basis of the linear function, we are making calculations of the unknown norm of relationship between the growth of labor productivity and the average wage (y), used for the development of norms of planned expenditure of the workers' wages and

planning of the wage fund for the perspective period. The magnitude of this norm depends, in our opinion, on the increasing share of increment in the volume of output at the expense of increasing labor productivity:

$$x = 100 - \frac{\Delta l}{\Delta q} 100,$$

where $\Delta l = \frac{\Delta L}{L_0} 100$--rate of increase of the number of workers,

$\Delta q = \frac{\Delta Q}{Q_0} 100$--rate of increase of the volume of production.

At the same time, by dividing the rate of growth of the volume of production by the rate of growth of the number of workers, we received the meaning of the rate of growth of labor productivity:

$$v = \frac{\Delta q + 100}{\Delta l + 100} 100.$$

Consequently, the norm of the share of increment of output at the expense of increasing labor productivity reflects the inverse quantity of its growth and the substantiated criterion of optimality for the standard solution of planned economico-mathematical problems of the subsystem "Labor and Personnel" of the ASPR, OASU [Industrial Automated Control System], and ASUP [Automated Control System of Production]. This norm ensures the minimization of labor expenditure for a unit of output and maximization of the growth of wages as the intensity of planned requirements in respect to the volume of production and labor productivity increases.

Proceeding from experimental calculations, it can be seen, that between y and x there is a linear dependence:

$$y = ax + b,$$

where a, b--parameters of the equation, reflecting the norms of the long-range effect of planning the wage.

However, the effectiveness of using this equation is reached only on condition that the twin meanings of its parameters are determined on the basis of not only data in the reports, but also data of the plan.

For the evaluation of parameters a and b of the linear function, two pairs of meanings of x and y are determined. The first pair expresses the initial information of the base period of 1975 (y_{75}, x_{75}), the second expresses planned indicators of 1980 (y_{80}, x_{80}).

Under these conditions we have calculated the parameters of the linear function applicable to the industry on the whole on the basis of statistical and norm and plan information (Table 2).

The meanings of the first pair (y_o, x_o) characterize not only the relationship of the growth of labor productivity and the average wage, but also the most important proportion between the growth of the volume of production and the growth of the wage fund, and comprise the basis of the calculation of parameters of equation of the connection of the linear function for the planned period.

Introduction of the linear function into the practice of normative planning and effective use of wages to stimulate the growth of production and labor productivity requires to bring the meaning of y_o to the normative aspect at the cost of excluding various supplementary payments, caused by the unsatisfactory work of enterprises and not included in the planned wage fund (deviations from normal working conditions, for overtime work, idle time, relative economy or overexpenditure of wages, and so forth). In different industries these supplementary payments constitute in the total wage fund approximately 1 percent, and in the average yearly calculation in industry on the whole, more than 400 million rubles.

Table 2.

Indicator	1970 (report)	Meanings of the first pair of equation (y_o, x_o) 1975 (report)	Meanings of the second pair of equation (y_n, x_n) 1976-1980
Average yearly wage S_o, rubles. . . .	1,512	-	-
Industrial-production personnel L_o, thousand persons.	31,593*	-	-
Norm of the share of increment in output through the increase of labor productivity, x_o, %.	-	84**	-
Norm of ratio between the growth of labor productivity and the growth of the average wage y_o, brought to the planned indicator, %.	-	0.39	-
Wage fund (according to report) F_o, million rubles.	-	57,520	
Growth of the volume of output q_n, %	-	-	137
Minimal growth of the average wage (variable parameter) S_n, %.	-	-	1.05

*"SSSR v tsifrakh v 1975 g." [USSR in Numbers in 1975], Moscow, Statistika, 1976, p 175.

**"Materialy XXV s"yezda KPSS," p 37.

The quantity of the minimal growth of the average wage (variable parameter) amounting to 105 percent is substantiated by the model of the calculation of the second pair (y_n, x_n) of the equation of the linear function, offered by us.

Thus, if the meanings of the first pair of the equation of the function (y_o, x_o) are adopted from the data in reports and brought to the norm aspect, the meanings of the second pair (y_n, x_n) are unknown and are determined by the following method:

$$S_0 : 1{,}05_n = S';$$

$$F_0 : S' = L';$$

$$L' : L^0 = l';$$

$$q_n : l' = v';$$

$$y_n = \frac{\Delta 5_n}{\Delta v};$$

$$x_n = 100 - \frac{\Delta l'}{\Delta q_n} 100.$$

Meanings, marked with a stroke, are derivative intermediate indicators, determined for the calculation of the equation parameters of the function. According to this model we calculate: the level of the wage with its minimal growth in the projected period: 1,512 · 1.05 = 1,588 rubles; the number of industrial-production personnel with the minimal growth of the average wage in the projected period 57.520 million rubles divided by 1,588 rubles = 36,220,000 persons as published ; increase of the number of industrial-production personnel with the minimal growth of the average wage in the projected period: $\frac{36{,}220{,}000 \text{ persons}}{31{,}593{,}000 \text{ persons}}$ 100% = 115.0%; growth of labor productivity with the minimal growth of the wage in the projected period: $\frac{137\%}{115\%}$ 100% = 119%.

Consequently, the meanings of the second point of the linear function, formed by the planned indicators for 1976-1980, constituted:

$$y_n = 5\% : 19\% = 0{,}26;$$

$$x_n = 100 - \frac{15}{37} 100 = 59{,}0\%.$$

By substituting the above known points (y_0, x_0) and (y_n, x_n) in the given equation of the linear function y ax b, we receive a system of linear equations:

$$y_0 = ax_0 + b;$$
$$y_n = ax_n + b.$$

Using this system, we find the unknown parameters:

$$\Delta y = y_0 - y_n = 0{,}39 - 0{,}26 = 0{,}13;$$
$$\Delta x = x_0 - x_n = 84 - 59 = 25;$$
$$a = \frac{\Delta y}{\Delta x} = \frac{0{,}13}{25} = 0{,}0052;$$
$$b = y_n - ax_n = 0{,}26 - (0{,}0052 \cdot 59) = 0{,}26 - 0{,}31 = -0{,}05;$$
$$y = 0{,}0052x - 0{,}05.$$

As a result of the solution of this planned economico-mathematical problem the existing in the Ninth Five-Year Plan relationships between the growth of the volume of output and the growth of the wage fund are carried over, taking into account the outlined tasks in respect to the growth of the volume of production and its intensiveness--the share of increment of output at the expense of increasing labor productivity for 1976-1980.

By substituting in the parameters of the equation of the linear relationship (y = 0.0052x - 0.05) the assigned according to the years of the Tenth Five-Year Plan variable norms of the share of increment of output at the cost of increasing labor productivity, we receive the unknown norm of relationship between the growth of labor productivity and the average wage.

If one adopts in the yearly plans x equal to 70, 75, 80, 85, 90, 95, 100, then y will be equal respectively to 0.31; 0.34; 0.37; 0.39; 0.42; 0.44; 0.48.

The relationship mentioned shows--the higher the outlined rates of growth of the volume of output, the greater the meaning of x, the bigger the y. With the lowering of planned tasks in comparison with the base five-year period the norm of the relationship between the growth of labor productivity and the growth of the average wage (y), and consequently, also the total wage fund are reduced accordingly.

The integrated approach to the improvement of the existing methods during the introduction of economico-mathematical methods in the planning of

labor productivity and the wage fund, using electronic computers, permits to automatize calculations of the plan and considerably reduce the volume of work when making perspective plans.

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CAREER GUIDANCE AND ECONOMIC FACTORS INVOLVED IN IT

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/Text/ At the 25th CPSU Congress it was noted that further improvement of the management of the economy in the broadest sense of this word is one of the key issues. At practice shows, still not all processes of social reproduction are sufficiently regulated and managed in conformance with the plan by the state. Referred to these processes is distribution of the labor force in the industries, enterprises, and regions. In this respect it is characteristic that the share of motives for the selection of a profession, based on skills and elements of professional orientation, constitutes 23 percent in industry, and 28 percent in construction.[1] Our survey in the city of Kostroma showed that 14 percent of 10th grade students questioned clearly motivated the reason for selecting a profession in 1965, and only 8 percent in 1974. Unable to respond to this question were respectively 28 and 22 percent of surveyed school graduates.

Consequently, only 10-20 percent of teenagers entering the working life choose their future profession consciously. The rest are governed mainly by casual motives. This situation has far-reaching economic and social consequences, because in a number of instances a person happens to be insufficiently fit professionally to carry out his selected work or has a psychologically negative attitude toward it.

The absence of a scientifically substantiated approach toward the selection of a profession (and later--of a job) first of all increases labor turnover. Such reasons as dissatisfaction with a profession, with working conditions, and unsatisfactory condition of health account for 20-38 percent of all labor turnover.[2] S. Batyshev thinks that "nearly 50 percent of labor turnover is the result of poor career guidance efforts."[3] According to data of the Scientific Research Institute of Labor, dismissals due to unfitness of workers for the profession constitute 23.7 percent of all dismissals; losses, on the other hand, caused by labor turnover in the nation, constitute substantial sums of money a year.[4] Thus, dismissals due to professional inadequacy, accounting for one fourth of all labor turnover, bring a loss amounting to approximately 1.3-1.5 billion rubles a year.

Dissatisfaction with a profession inevitably causes the retraining of a worker. According to data of the MGU /Moscow City Administration/ labor resources laboratory, 31.7 percent of agricultural workers change their profession yearly.[5] No less than 0.9-1.0 billion rubles are being spent on their retraining (maybe, even repeated).[6]

Turnover and the change of skills, connected with it, can hinder the growth of a worker's qualification. Thus, workers of Moscow enterprises who have not changed their place of work at all have a grade category of 4.0 with a 6-year length of service, whereas those who have changed four places of work have an average grade category of 3.7 with a length of service of 16.1 years.[7] Due to the turnover of personnel labor productivity too is lowered. When workers change their place of work, they underfulfill the norms in the first month by 25-30 percent, in the second month by 10 percent, in the third by 3-5 percent, and only later adjust themselves to the general tempo of work.[8]

Irrespective of the change of jobs, labor productivity of workers, meeting the demands of their chosen profession, is on the average 20-40 percent higher due to greater labor intensiveness than that of workers who do not correspond to these demands. According to the calculations of N. I. Sidorov and M. T. Makhan'kova, with the correct choice of professions the economy for 1,000 young workers through the growth of labor productivity applicable to the plan for 1975 would have constituted 458,000 rubles with the general 6-percent growth of labor productivity.[9] In 1975 the vocational-technical learning institutions alone trained 2 million young workers; consequently, with scientifically substantiated selection of professions the total effect would have been equal to not less than 1.0-1.5 billion rubles.

Incorrect selection of a profession has a negative effect not only on labor productivity, but on the quality of work as well. On the whole such selection of a profession brings to the national economy economic harm of the type of "shortfall in income," amounting, according to the most minimal calculations, to 3-4 billion rubles a year. Also of no lesser importance is the social aspect of this matter: When there is dissatisfaction with a profession, a person finds it difficult to develop his personality, his creative attitude toward work. Even in a developed socialist society the position of K. Marx that "delusion in respect to our aptitude for a particular profession... is a mistake that avenges itself" is still in force.[10] Moreover, in our conditions, when there are absolutely no social obstacles in the way to one or another profession and any work which brings benefit to the society is considered honorable, negative consequences of mistakes in the selection of a profession are augmented.

As a result of psychophysiological unfitness for work and negative attitude toward it there arise overexertion of the nervous system and conditions of stress. Probably those sociologists are right who consider that systematic failures at work create an attitude of depression, indifference, envy, animosity, consumerism. This attitude is also carried over to the other aspects of life which are not connected with the production collective directly. A

favorable ground for acquiring unhealthy habits and backward opinions is created.[11] The increase of neuropsychic stress without sufficient adaptability to it, constant need to do disliked work, and contradiction existing for years in the sphere of work between "I want" and "I must" cause diseases of the nervous and cardiovascular systems.[12] Scientists of the Institute of Gerontology of the AMN SSSR /USSR Academy of Medical Sciences/ have come to the conclusion that "absence among young people of the necessary work according to their professional orientation in more advanced age leads to the reduction of age limits of professional fitness for duty."[13]

In order to manage the distribution of the work force it is first of all necessary to have accurate knowledge of the perspective demands of society for labor resources in individual regions and widespread information for the population about these needs (profinformation). Determination of the demand for the work force is made in the process of national economic planning. However, this need in many respects remains unknown to the population, and this deprives it of an opportunity to form an opinion about its future professional placement which would be tied in with the national economic plans. "If we advertise," justly notes B. Chernyakov, marker of the Kirov Plant, "resorts and tourist routes--places where a person rests, we have all the more right and duty to advertise places where a person works, creating material welfare for the society."[14]

Satisfaction of demand for the work force is ensured on the basis of proportionality between the material and personal factors of production which has not only a quantitative, usually taken into consideration, but also a /qualitative/ /printed in italics/ side. The classics of Marxism-Leninism often emphasized the difference in the natural peculiarities of people, including the difference in their capabilities. Young K. Marx wrote: "In a physical condition which does not correspond to our profession we are in no condition to work for a long time and we seldom work gladly. However, if we have chosen a profession for which we do not have the necessary aptitude, we will never fulfill it in a proper manner."[15] The thought that the aptitudes of people, and consequently, also their possibilities applicable to one or another type of activity are unequal was also emphasized by V. I. Lenin. He wrote: "...in a socialist society it is preposterous to expect /equality/ /printed in italics/ of the fortitude and aptitutes of people." And further on: "...when socialists speak about equality, they understand it always as /social/ /printed in italics/ equality, and by no means as equality of physical and spiritual abilities of individuals."[16] In his work "State and Revolution" V. I. Lenin again calls attention to the fact that people are "different," "in actual fact not equal," "not equal to one another."[17]

Differences in the innate properties of individuals determine their professional fitness. Physiological properties, causing these differences, predetermine the degree to which one or another individual is capable of mastering a given range of professions. A person unfit for this range of professions, cannot be made fit by any training: in this case the training of functions does not occur.[18] A worker who is not predisposed to a particular

profession is not a rare phenomenon. It has been proved by extensive survey that because of professional contraindications 7-8 percent of young people cannot master professions connected with the assembly of small parts; some 15-20 percent, the profession of apparatus operator in chemical production; 20-40 percent cannot work as a high-level mounter; and 60-80 percent of all those enrolling in the training do not master the professions of grinder-polisher of complicated curved surface parts or fitter-pattern maker.[19] At the same time there are no people absolutely unfit for any profession; for each one can and must find such a place in the system of social production where he could attain high labor productivity on the basis of the discovery and full use of his abilities and receive satisfaction from this.

The existence of professional unfitness makes it necessary to determine the range of professions, recommended and contraindicated to a particular individual (profpodbor), and also to check a person's fitness to do work which he intends to master (profotbor). Practice proves that a positive conclusion about fitness for one or another profession is confirmed in 97 cases out of 100, and a negative conclusion, by a full 100 percent.[20]

Professional fitness is substantiated not only by the natural properties of a worker, but also by his desire to carry out definite professional functions, i.e. by a subjective attitude toward work which is formed under the influence of numerous elemental factors.[21] Attitude toward work, formed in the beginning of a working career, is stably maintained later on as well (Table 1).

Table 1. Relationship Between Conscious Selection of a Profession and Satisfaction With Work Among Graduates of the Kostroma Technological Institute

Consciousness in the selection of a profession and attitude toward it when entering the institute	Attitude toward work after graduation from the institute and several years of work (% of the total)	
	Like	Don't like
Had an idea about the profession and entered the institute by vocation . . .	96	4
Had no idea about their chosen profession when entering the institute . .	65	35
Had an idea about their chosen profession, but enrolled unwillingly . . .	58	42
T o t a l . .	82	18

Definite attitude toward work in one or another profession is instilled in the process of /professional orientation/ [printed in italics]. Planned proforientation must base itself on the data of "profpodbor" about the professional fitness of an individual and guide the graduates toward mastering professions, needed by the society. The 24th CPSU Congress emphasized that it is necessary to conduct "work in respect to professional orientation of students, taking into account the inclinations of youth and the needs of the national economy for skilled personnel."[22] To persuade a youngster to select out of professions, necessary to the society, one for which he is best suited and after having mastered which he will function in the process of production with the highest labor productivity and quality of work --such is the task of planned, scientifically founded proforientation. In the economic aspect professional orientation is an element of the management of the process of labor force movement through management of the selection of a profession.

At the present time professional orientation is carried out to a considerable degree under the influence of chance coincidence. This is evidenced by the results of sociological research, conducted by us among the graduates of Kostroma schools and students of the Kostroma Technological Institute (Table 2).

Table 2. Forms of Influence on the Professional Vocation of Youth at the Kostroma Technological Institute* (% of the total)

Source of information which inspired interest in the selected profession	10th grade students of the city of Kostroma, 1974	Third year students of the Kostroma Technological Institute	
		1968	1974
Observation of a worker or personal contact with him	31	2	4
Literature, works of art, mass information means	19	13	17
Parents or relatives	14	13	14
School, incl. industrial training . .	12	3	7
Friends	6	12	17
Institute, tekhnikum, GPTU [City Vocational & Technical Schools] (study or visits)	5	25	23
Work	3	7	17
No response received	10	25	1

* Schools where the observation was carried out are in different rayons of the city (central, factory-plant, in the outskirts, region of new construction). In all, 384 questionnaires were received from the graduates which constitutes 88 percent of the contingent of 10th graders of schools surveyed and 25 percent of all 10th graders in Kostroma. Therefore, this selective survey is sufficiently representative.

The preferred forms of influence on the professional inclinations of youth are professional guidance, work at school, and industrial education: study at an institute, tekhnikum, GPTU or visitation of this educational institution during the school year (circles, electives, open house days, and so forth); work prior to entering special educational institutions (for schoolchildren--during vacations). Even if one digresses from the fact that professional guidance of schoolchildren according to these channels far from always takes into account their aptitudes and inclinations (there is no profpodbor), it so happens that for third year students the share of these sources of information, determining the selection of a profession, hardly reaches one half, and for the graduates of schools it constitutes only 20 percent. Moreover, 85 percent of parents recommend their children to master more "prestigious" professions than they themselves have, taking into consideration neither the natural inclination of their children, nor the need of society for these professions.[23] In the light of the data given one should not be surprised that 23 percent of 10th graders of the city of Kostroma want to be engineers, 21 percent want to be doctors. Survey, conducted in 1972 among schoolchildren of the Kievskiy Rayon of Moscow, showed: approximately one third of schoolchildren wanted to become engineers, doctors, or teachers, and less than 1 percent wanted to become workers.[24] Only 5 percent of schoolchildren in the city and oblast of Leningrad intended to work in the industry, and 4 percent in agriculture and services, whereas these industries needed respectively 61 and 25 percent in respect to the total requirement.[25]

Over the past few years work in respect to professional selection and professional guidance has been acquiring wider and wider scope. Thus, at the Tiraspol' Sewing Factory profotbor /professional selection/ is being practiced during hiring. At one of Riga's enterprises a computer gives data on the degree of correspondence of one or another worker to the requirements pertaining to the position. The Leningrad LOMO Firm checks out professional fitness of future workers at its vocational-technical school. Educational (school) plants are functioning at the enterprises of Moscow, and also at the Khar'kov Tractor Plant. In Leningrad, Alma-Ata, and other cities interschool educational production combines for work and professional orientation of schoolchildren have been and are newly created. At the enterprises, in the schools and PTU of Leningrad there are professional-consulting centers and bureaus for professional guidance. In the schools of Kostroma Oblast 400 technical circles and 285 school brigades have been created. More than 1,000 graduates of secondary schools in the oblast stayed to work in agriculture in 1976.

What has been done, however, far from meets the needs of the national economy. The 25th CPSU Congress pointed out the necessity /"to pay more attention to the labor education of schoolchildren, to the professional orientation of youth."/ /printed in italics/[26]

Professional guidance, in our opinion, should develop on the principles of complexity, universality, and centralism, being one of the levers of planned

management of labor force distribution and redistribution on the basis of aim-directed influence on the selection of a profession, more and more becoming the element of planned management of the economy.

A complex approach toward professional guidance is needed because without professional selection and professional information it loses its scientific nature and does not give due economic effect. Thus, the Volga Motor Vehicle Plant in the city of Tol'yatti hardly needs any advertising. However, part of the workers at this plant are unable to master a whole series of professions differing in complexity, being professionally unfit.[27] Widespread guidance to develop the wealth of Siberia leads to the fact that, for example, to the city of Nizhnevartovsk thousands of people come every year, far from all of whom are adapted to the rigorous climatic conditions of life there.[28]

Professional orientation finds its natural foundation in professional selection /profpodbor/. The determination of professional fitness (profpodbor) gives an opportunity to find out to which professions, working and living conditions an individual is best suited according to his psychophysiological properties. He can be guided exactly to these professions and conditions, because only there the use of his work force will give the biggest economic and social effect.

The social purpose of orientation is stipulated by professional information about the perspective demand of a given region for the labor force. Out of all professions for which an individual is best suited, only those should be the object of professional information which are necessary to the society.

Thus, without professional selection /profpodbor/ professional orientation is groundless, and without professional information, aimless. Professional orientation coordinates social need for the work force with the natural foundation of its satisfaction on the part of quality, making the objective need for this satisfaction the subjective purpose of individuals by way of approximating personal and social interests in choosing a profession.

In principle, all professions should be subjected to professional selection and professional information, i.e. professional orientation must be /all-around/ /printed in italics/. The most mass professions also require quite definite natural qualities. For example, a survey of 15,000 Leningrad schoolchildren 15-17 years of age showed: 20-24 percent of youngsters could not work in textile and hot shops; 20 percent of those questioned were unfit to work in conditions of vibration and noise; 12-15 percent of Leningrad schoolchildren were unfit for work on the conveyor.[29] In exactly the same way, if not to a greater extent, absolutely not all can be considered fit to work as salesmen and other workers in services.

Intellectual professions are no less in need of professional guidance (and its premise--professional selection) than mass professions. Thus, it has been established that professional pedagogic aptitudes, like all psychic functions,

are formed on the basis of inborn anatomicophysiological inclinations; the work of a pedagogue requires special professional talents and special personal qualities.[30] However, professional selection and professional guidance in pedagogical VUZ's is practically nonexistent. As a result, up to 50 percent of graduates choose the profession of teacher accidentally, 20-25 percent graduates of these VUZ's are indifferent to their work, and 20 percent try to avoid pedagogical work, nearly one third of teachers are not satisfied with work in the school. More than 300,000 persons with a higher education are engaged in industry, working not according to their professions, a majority among them are graduates of pedagogic learning institutions.[31]

The situation is analogous also in other VUZ's. Thus, in the Crimean Medical Institute one fourth of all enrollees have poor knowledge of the profession of a medical doctor.[32] In the Kostroma Technological Institute 75.8 percent of those questioned were sufficiently knowledgeable about their chosen profession, however, only 44.2 percent out of them liked their future profession, and 3.6 percent did not like. A survey in nine VUZ's in the RSFSR showed that 60.1 percent of all students would have repeated the selection of a profession, and 16.6 percent would have not, whereas 25.6 percent of students are already in their fifth year; in approximately one third of students the attitude toward their chosen profession changed for the worse as they studied.[33] In the light of this data the circumstance that from 1960 to 1975 the dropout from VUZ's constituted not less than 25 percent of enrollees causes no surprise.[34] Leaving the VUZ's are those who are incapable of studying or those who have become disenchanted with the profession, which once again confirms the need for effective scientifically founded professional orientation and professional selection.

Professional guidance must be universal, i.e it must embrace all teenagers, even in that case when their professional fitness for doing particular work is seemingly indubitable. Thus, out of several thousand contestants only 300-400 each year win the right to study at the Novosibirsk Physico-Mathematical Specialized School, out of whom 80 percent enroll in the Novosibirsk University.[35] However, those who passed the competition to enter the school and undoubtedly have mathematical talents, may have even greater pedagogical, musical, or organizational talents which with such a selection remain unrevealed and, therefore, not utilized.

Very scarce, especially these days, are organizational talents. Psychologists have determined 18 personality trends which should be characteristic of an able organizer.[36] A selection in VUZ's according to these trends would have permitted to select talented organizers according to the plan, who later on could have been promoted to corresponding administrative positions in production. "Professional orientation to become organizers" is also necessary, all the more because at present young specialists often avoid organizational work. If the graduates of the Kostroma Technological Institute evaluated their engineering erudition as 3.9 points, their ability to manage people they evaluated only as 3.1 points. A survey in the VUZ's of Leningrad showed that only 16.4 percent of students wished to work directly as organizers of

production,[37] the rest were eager to get into scientific research institutes, design bureaus, planning organizations, get ordinary positions where there is no organizational activity.

Practical solution of the problem lies in the /centralization/ /printed in italics/ of professional guidance efforts. V. I. Lenin used to put the degree of maturity of socialist production relations in direct dependence on the distribution of labor by the state in conformity with the plan. He wrote: "Labor is united in Russia in a communist way, because... /the state... distributes the work force/ /printed in italics/ among different industries and enterprises."[38] Adequate to the social nature of production, to the socialist property of the means of production, to the aggregate worker of society, to the unified national interest of workers is likewise social, state, planned management of reproduction of the work force. One ought to agree with the authors who raise the question about the creation in the nation of a unified organ in charge of labor resources,[39] included in which would have been a national system of professionalization of the public.

The creation of a national organ, realizing the professional guidance of youth (together with professional selection and professional information), would have permitted to resolve from the position of national economic tasks the problem of supplying the enterprises with personnel which is now often resolved by the enterprises themselves from the position of departmental interests and not rationally enough. There are many examples of this. Thus, as a result of activities of the professional guidance service at the Ural Heavy Machinery Plant imeni Sergo Ordzhonikidze, the number of those wishing to work at the plant in 1974 had increased twice in comparison with 1972.[40] For the enterprise this is success without question, however, the national, final meaning of such work could turn out to be, at least theoretically, negative, if through this some other important sectors of the economy are deprived of the work force. The creation of a unified national system of professionalization of the public, considerably increasing the possibility of managing the movement of the work force in conformity with the plan, would have permitted on this basis to raise the level of planned management of the national economy. This would have helped to bring the losses, which have been mentioned above, to the minimum.

The expenditure for professional orientation constitutes 3-4 percent of the schools' budget, and the outlays for professional selection, not more than 2 percent of the total cost of teaching the profession.[41] Proceeding from the expenditure of the state budget for the upkeep of general education schools of all types and for the training of personnel, it can be concluded that total outlays for professional selection and professional guidance will constitute no more than 0.5 billion rubles a year. In this way, according to the most modest calculations, the yearly economic effect from the professionalization of the public will constitute more than 3 billion rubles. Even more significant is the social effect which is of huge importance to the successive development of the socialist way of life and to the strengthening of the creative nature of labor.

FOOTNOTES

1. "Trudovyye resursy: formirovaniye i ispol'zovaniye" [Labor Resources: Formation and Utilization], Moscow, 1975, p 174.

2. Ye. S. Rusanov, "Raspredeleniye i ispol'zovaniye trudovykh resursov SSSR" [Distribution and Utilization of USSR Labor Resources], Moscow, 1971, p 114; "Problemy povysheniya effektivnosti ispol'zovaniya trudovykh resursov" [Problems of Increasing the Effectiveness of Using Labor Resources], Moscow, 1973, p 127; G. S. Savoin, "Tekuchest' kadrov: prichiny i preduprezhdeniye" [Labor Turnover: Reasons and Prevention], Moscow, 1971, p 30.

3. S. Batyshev, "Professional Guidance--An Important Social Problem," SOTSIALISTICHESKIY TRUD, 1975, No 12, p 87.

4. S. V. Komarov, V. D. Nosikov, "Tvoye rabocheye mesto" [Your Work Place], Gor'kiy, 1974, p 42.

5. V. S. Nemchenko, "Mobility of Labor Resources," VESTNIK MGU, series Ekonomika, 1974, No 1, p 69.

6. "Vsesoyuznoye soveshchaniye nauchnykh rabotnikov po okhrane truda. 12-15 iyunya 1972 g." [All-Union Conference of Scientific Workers on Labor Safety], theses of speeches, Moscow, 1972, p 46.

7. "Sotsial'no-ekonomicheskiye problemy narodnogo obrazovaniya" [Socioeconomic Problems of Public Education], Moscow, 1969, p 275.

8. "Sotsiologicheskiye problemy obrazovaniya i vospitaniya" [Sociological Problems of Education and Upbringing], Moscow, 1973, p 134.

9. N. I. Sidorov, M. T. Makhan'kova, "Effektivnoye ispol'zovaniye truda molodezhi" [Effective Utilization of Young People's Labor], Moscow, 1974, pp 73-74.

10. K. Marx and F. Engels, "Iz rannikh proizvedeniy" [From Early Works], Moscow, 1956, p 5.

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12. "Problemy proforientatsii i profkonsul'tatsii v shkole" [Problems of Professional Guidance and Professional Consultation in School], Moscow, 1969, p 112; Ye. Chazov, "The Age and the Heart," PRAVDA 18 May 1976.

13. "Professional'naya orientatsiya i konsul'tatsiya molodezhi" [Professional Guidance and Consultation of Youth], Kiev, 1966, p 25.

14. "My i nashe delo" [We and Our Duty], Moscow, 1974, p 12.

15. K. Marx and F. Engels, "Iz rannikh proizvedeniy," p 3.

16. V. I. Lenin, "Poln. sobr. soch." [Complete Collected Works], Vol 24, p. 364.

17. IBID, Vol 33, p 93.

18. I. Kartsev, "Ishchi svoyu professiyu" [Search for Your Profession], Moscow, 1973, p 66.

19. A. P. Solov'yev, "Pravila vybora professii" [Rules for Selecting a Profession], Leningrad, 1975, p 70; I. Nazimov, "Before a Thousand Roads," KOMSOMOL'SKAYA PRAVDA 16 January 1969.

20. "Kem byt'?" [Whom To Be?], Moscow, 1975, p 65.

21. V. N. Shubkin, "Selecting a Profession," SOVETSKAYA PEDAGOGIKA, 1968, No 2, p 58; also his, "Starting Out," NOVIY MIR, 1976, No 2.

22. "Materiyaly XXIV s'yezda KPSS" [Materials of 24th CPSU Congress], Moscow, 1971, p 227.

23. "Sem'ya i shkola" [Family and School], 1975, No 11, p 26.

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27. V. A. Troshikhin, S. I. Moldavskaya, "Psychophysiological Foundations of Professional Selection," VOPROSY PSIKHOLOGII No 3, 1974, p 170.

28. N. Rozhkova, "City With a Komsomol Badge," KOMSOMOL'SKAYA PRAVDA 1 June 1976.

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30. T. A. Vorob'yeva, "Experimental Research of Professional Fitness for the Profession of Teacher," in the book "Problemy vysshego pedagogicheskogo obrazovaniya" [Problems of Higher Pedagogic Education], Leningrad, 1971; F. N. Gonobolin, "Pedagogicheskiye sposobnosti i ikh klassifikatsiya" [Pedagogical Aptitudes and Their Classification], Moscow, 1970; N. V. Kuzmina, "Ocherki psikhologii truda uchitelya" [Essays on the Psychology of Teacher's Work], Leningrad, 1967; E. N. Solovtsova, "Study of the

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We are taking the work of a pedagogue as an example, because due to understandable reasons it has been studied the most; everything which has been said about the work of a pedagogue, in this case can also be said about the work of an engineer.

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32. P. Yermishin, "Candidate for the Position of Engineer," PRAVDA 15 Jan 1976.

33. G. A. Zhuravleva, "Student segodnya (vybor professii)" [Today's Student (Selection of a Profession)], Leningrad, 1975, p 18.

34. "Ekonomika i obrazovaiye" [Economy and Education], Collected works of MOPI, Moscow, 1975, p 85.

35. Z. Ibragimova, "Address of the School--Akademgorodok," PRAVDA 25 March 1976.

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37. G. A. Zhuravleva, "Student segodnya," p 20.

38. V. I. Lenin, "Poln. sobr. soch." Vol 39, p 273 (italicized by us--A. S.).

39. V. N. Shubkin, "Youth Enters Life," VOPROSY FILOSOFII No 5, 1965, p 60; M. Ya. Sonin, "A Scientific System of Professional Orientation Is Needed," SOTSIALISTICHESKIY TRUD No 7, 1968, p 69; "Vosproizvodstvo rabochey sily i povysheniye effektivnosti ispol'zovaniya trudovykh resursov" [Reproduction of the Work Force and Increase of the Effectiveness of Using Labor Resources], Moscow, 1971, p 89; EKONOMIKA I ORGANIZATSIYA PROMYSHLENNOGO PROIZVODSTVA No 4, 1974, p 7; "Trudovyye resursy: formirovaniye i ispol'zovaniye," Moscow, 1975, p 174; S. Sirotkin, "Formirovaniye proizvodstvennykh kollektivov" [Formation of Production Working Collectives], Yaroslavl', 1976, p 15.

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